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THE BEGINNING PARACHUTIST

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By

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Purpose and Classification of Parachutes

All parachutes used in the Soviet Army, various branches of the national economy and scientific research can be divided into five groups according to purpose:

--personnel parachutes for safe descent in the air, landing or water entry of persons;

--cargo parachutes for safe descent of cargo to the ground from aircraft;

--braking parachutes for braking of various bodies moving in an air medium;

--special purpose parachutes;

--supplementary parachutes.

Personnel parachutes include four types:

--landing training parachutes, used for combat and training jumps of military parachutists, and also for training purposes;

--sports training parachutes, designed for sports competitions and training of sports parachutists, who already have the necessary experience in jumping with landing-training parachutes.

Sports training parachutes differ from landing training parachutes in their design, have good controlability during descent and can be moved horizontally due to slots cut in the canopy;

--reserve parachutes, used for safe descent and landing of persons in case of a failure of the main parachute or in case it is impossible for some reason to open the main parachute;

--rescue parachutes, used for safe return of crews forced to leave aircraft in flight.

Landing training parachutes include the D-5, D-1-8 and D-3 of various series and modifications, sports training parachutes include the D-1-5u, T-4, UT-2 of various series and modifications.

Sports training parachutes also include the PD-47, used to train beginning sports parachutists, although it is also used sometimes as a landing training parachute.

The type 3-1p and 3-3 are the most commonly used reserve chutes; the S-2, S-3 and others are rescue parachutes.

Two types of cargo parachutes are known: single-canopy types, used to lower relatively small cargoes and multiple-canopy types (parachute systems) for safe descent of heavy cargoes such as motor vehicles, artillery weapons, tanks, etc.

Braking parachutes include aviation types, used to slow down high speed aircraft in order to reduce the length of their required landing run.

Special purpose parachutes include several types used for the following purposes:

--reduction of the falling rate of flare rockets,
--stabilization of the motion of various bodies in the air;
--safe descent of spacecraft to the surface of the planet;
--safe descent of pilots ejection seats following ejection from an aircraft;
--determination of the point of separation of parachutists from an aircraft (target parachutes) and others.

Supplementary parachutes are parachutes which assure reliable operation of the canopies of main parachutes. They include supporting parachutes, designed to hold the peak of the main canopy up as it opens, and pilot parachutes (their purpose will be discussed below).

Principles of the Design of Parachutes

A parachute is a device designed to reduce the rate of movement of a body through air. The operating portion of the parachute consists of a soft structure, capable of occupying a relatively small volume in folded form, which opens to take up the form of a large canopy when put into use.

A simple parachute design consists of the following.

Take an ordinary handkerchief and four pieces of thread, each 50-60 cm long. Tie one end of each piece of thread to the corners of the handkerchief, tie the other ends together and make a small loop or tie a piece of cloth to them. This is a model of a parachute. Like a real parachute, this model has three main parts: the canopy (handkerchief) to create resistance to movement through the air; the lines (threads) to suspend an object from the canopy and the suspension system (loop or cloth) for convenient placement of the parachutist or cargo.

This type of parachute can provide safe descent to the earth not only of small objects, but of living animals weighing up to a few dozen grams. For heavier cargoes or animals, the canopy must be larger, the lines stronger, and the suspension system more convenient.

To provide safe descent rates, about one square meter of canopy area is required for each one kg of weight lowered. Therefore, parachutes for use by people have canopy areas on the order of 60-80 m^2.

The packs of modern personnel parachutes of various designs, although they differ in shape, dimensions and other specific features, are quite similar to each other. They are all reminiscent of a postal envelope (Figure 3). The flaps have closure devices (Figure 4) consisting of cones with apertures for pins on some flaps and holes (apertures for the cones) on other flaps, holding the flaps in the closed position. The flaps are held closed by pins attached to the rip cord. When the pack is closed, the cones enter their matching holes and the pins are placed in the cones over the holes.

In order to give the pack the required shape and create the best possible conditions for ejection of the canopy and lines, a rigidity frame is sewed into the bottom of the pack, and plates are sewn into the flaps. Around the edge of the bottom of the pack and its flaps, near the closure devices, wire loops are sewed around the outside. After the parachute has been folded and the pack is closed, pack rubber bands[1] are stretched in the direction from the flaps to the bottom of the pack; these bands have metal hooks on the ends. As soon as the pins are pulled out of the cones, the flaps of the pack are instantly opened by the rubber bands and pulled aside, and the canopy and lines fall out of the pack. If this occurs after the parachutist has jumped into the air, the canopy and lines are immediately pulled upward by the passing air stream.

In order to prevent the lines from leaving the pack too soon and becoming tangled in the canopy, special loops are made on the bottom of the pack, into which the lines are inserted as flatened zigzags. Also, small pockets are sewn into the outside of the canopy from the middle toward the top, to act as extracting devices. The airstream first catches the top of the canopy, then draws out the canopy to its entire length, then the lines. The process of opening of the parachute occurs in such a way that reliable filling of the canopy with air occurs, and its lines cannot become twisted or tangled in the canopy[2].

When a parachute opens, the rapid filling of the canopy with air causes sharp deceleration. The parts of the parachute and the parachute itself are subjected to a brief but severe loading--opening shock.

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[1]Parachutes used for high altitude jumps where the air temperature is low and rubber loses its elasticity use fabric-covered thin steel springs instead of rubber bands.

[2]Modern reserve parachutes are made according to this plan.

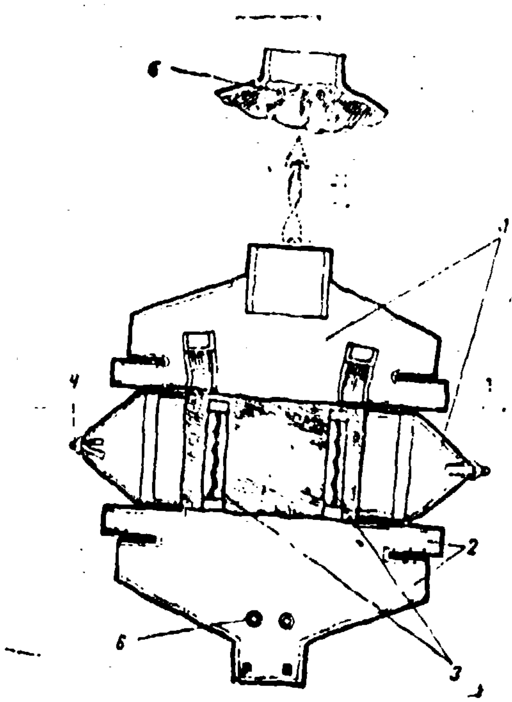

Figure 3. Parachute Pack (Reserve Chute)--
Inside View: 1, Flaps; 2, Tuck Flaps; 3, Loops;
4, Clasp Flap; 5, Cone; 6, Hole

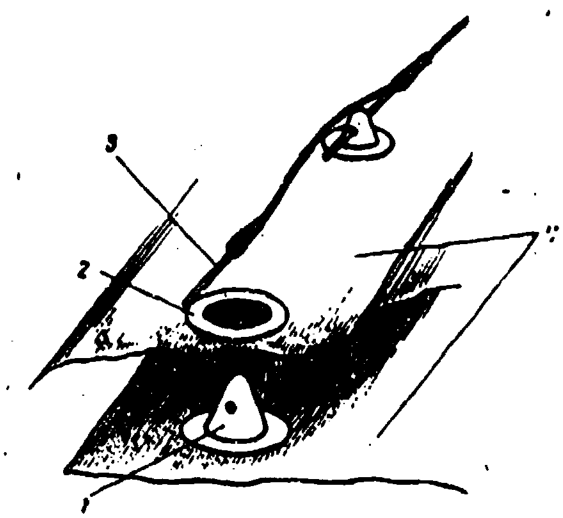

Figure 4. Closure Device of Parachute Pack:
1, Cone; 2, Hole; 3, Pin; 4, Pack Flaps

The parts of the parachute are not damaged by this shock, since they are all made with a great strength reserve, i.e., designed for a load which they will never be required to bear (see the table of strengths of important elements of parachute design), but it is painful for a parachutist to withstand high loadings.

TABLE

Strengths of Primary Structural Elements of Parachutes

Parachute Part	Maximum Possible Loading During Use, kg	Type of Material Used	Strength of Material (Tensile Rupture Force), kg
Suspension System Strap	400	PLK-44	1600
Main Parachute Line	50	SHKHBP-125 10 KP-0 10KP	125 150 200
Canopy Reinforcing Framework Strap	50	LTKP-25-200	200
Stabilizing Straps	100	LTKP-26-600	600
Ripcord	60	SHKKP-27-1200 SHKKTPkp-27-1200	1200 1200

To prevent this, the designers have produced a special cover for the canopy.

The canopy cover is designed to extract the canopy and lines to their entire length in the airstream before the canopy is filled, thus assuring optimal conditions for opening of the canopy. The cover also decreases the possibility of tangling of the canopy by lines and slows the process of opening of the parachute, thus softening the opening shock.

The cover (Figure 5) is in the shape of a sleeve. It is usually equal in length to the size of the canopy from edge to peak, in width to the width of the bottom of the pack. The folded canopy is placed within the cover, the bundle of lines, in the form of zigzags, is placed in the special loops. The lines in the loops are covered with a safety strap to protect them from being blown out by the airstream as the parachute is opened. To prevent the canopy from being pulled out of the cover too early and prevent it from falling beneath the lines (which would cause the lines to tangle it), the base of the cover is checked. For this purpose, the base of the cover carries an apron with windows. The lower loops pass through the windows and the first bundle of lines is drawn through them over the windows. The canopy can now be pulled out of the cover only after the lines are drawn out to their entire length, freeing the checking loops.

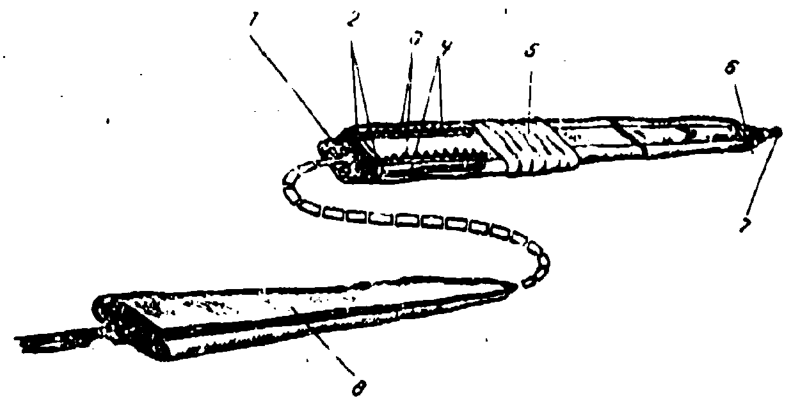

Figure 5. Parachute Canopy Cover and Canopy Prepared for Placement in Cover: 1, Apron; 2, Checking Loop; 3, Loop; 4, Frame Pocket; 5, Safety Strap (Tight); 6, Puller Pocket; 7, Ring; 8, Folded Canopy

Reserve parachutes and some soft pilot parachutes have no covers.

The canopy of a reserve parachute has no cover because it is opened not only in case of total failure, but also in case of partial failure of the main canopy (for example in case of a torn canopy or a canopy tangled with lines), as well as with the main parachute normally open (for training). In these cases, the rate of descent of the parachute is not sufficient to pull the cover off of the canopy.

The canopies of some light pilot parachutes have no covers because, due to their small size, they operate quite reliably without a cover.

If a parachute does use a cover, the airstream, after the pack is open, catches and carries away not simply the top of the canopy, but the upper portion of the cover together with the top of the canopy folded inside it. For this reason, pockets are also sewn into the upper portion of the cover to act as an extracting device. However, the drag created by the pockets is too little to provide any noticeable deceleration of fall and to assure rapid extraction of the lines from the pockets of the cover (the canopy itself can be pulled out of the cover with little force). Therefore, a pilot parachute

(100 times smaller than the main parachute) is attached to the upper portion of the cover (to the ring).

The pilot parachute provides the force to pull the lines out of the loops in the cover and pull the cover off of the canopy. It also decreases the rate of fall of the parachutist slightly during the period between opening of the parachute pack and completion of removal of the cover. Further deceleration occurs as the main canopy opens.

In order that the pilot chute might enter the airstream immediately, not remaining in the aerodynamic "shadow" or adhering to the parachutist, the pilot parachute is ejected away from the pack with some force by a spring mechanism which is sewed into the pilot parachute. The springs of this mechanism are compressed as the parachute is placed in the pack, then held in the compressed state by the flaps of the pack. To prevent the pilot parachute from being tangled, it uses a grid system rather than lines and is made in the shape of a ball.

Pilot parachutes without spring mechanism are also used (Figure 6). In this case, however, the flap of the pack carries a special apron on the inside near the closure device, into which the soft pilot parachute is tightly rolled as the parachute is placed in the pack. The pilot chute is ejected together with the flap and apron by the force of the pack bands as the pack is opened.

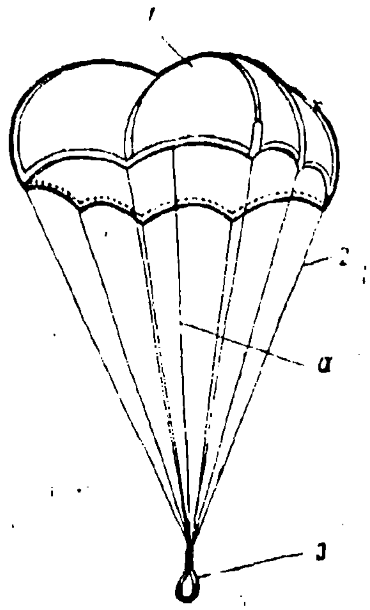

Figure 6. Soft Pilot Parachute: 1, Canopy; 2, Lines (a, Central Line); 3, Ring

Training, sports and rescue parachutes differ from each other in the shape and dimensions of the canopy, pack and cover, as well as the lengths of the lines, design of suspension systems and pilot chutes.

All of these parachutes work reliably. However, as they open at high flying or falling speeds, strong opening shock is produced. This shock may be acceptable for a pilot who is forced to bail out, or for a sports parachutist, but may be too great for a paratrooper, making a jump with full equipment, gas mask, radio transmitter and other supplies.

In order to stabilize the fall of the parachutist immediately after leaving the aircraft and decrease the rate of fall still more, thus greatly reducing the opening shock, another, stabilizing parachute may be placed between the pilot chute and the canopy of the main chute. This parachute, in addition to its main purpose, acts as a pilot chute after completing its stabilization function.

The stabilizing chute is several times greater than the pilot chute. It has no spring mechanism. It is placed in a cover designed for it. The purpose of the cover of the stabilizing parachute and its design are similar to those of the cover of the main parachute.

The stabilizing parachute is fastened by its ring loop to the ring on the cover of the main canopy in place of the pilot chute, while the pilot chute is fastened to the upper portion of the cover of the stabilizing chute in order to put it in operation and assure reliable operation of the stabilizing parachute alone.

To prevent the lines and main canopy from leaving their cover too early, during the process of stabilization, the lower portion of the cover is held in the pack by means of strong straps with clasps on their ends. As the parachute is folded, the clasps are placed in a special hook of the stabilizing device on the bottom of the pack. After the stabilization time passes, the hook is opened (manually or by a timer), the straps are released and the cover containing the main canopy is pulled out by the stabilizing parachute.

Landing parachutes operate in this manner.

When jumps are made from slow aircraft, when a version of forced extraction of the cover with the stabilizing parachute by the rip cord is used, no pilot parachute is used.

Design of a Landing Parachute

Let us study the structure[1] and capabilities of the D-1-8 series 5 landing parachute.

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[1]Detailed technical characteristics of various parachutes are given in technical descriptions and instructions for their folding and use.

The design of this parachute allows jumps to be made from aircraft flying at up to 350 km/hr with immediate opening of the pilot parachute. Using the D-1-8 series 6 parachute, jumps can be made from the An-2 aircraft with forced extraction of the cover with the main or stabilizing canopy by means of a rip cord and from the Yak-12 aircraft with forced extraction of the cover containing the main canopy.

The force which must be applied to pull out the rip cord is not over 16 kg.

The minimum safe altitude for jumping with immediate opening of the parachute is 150 m, with 5 second stabilization--no less than 300 m.

The parachute is stable in descent. The descent rate is not over 5 m/sec (with a total weight of parachutist up to 120 kg).

The length of the parachute folded in the pack is 600 mm, width 340 mm, height 265 mm. The weight of the parachute without its carrying bag and safety device is not over 20.5 kg.

The parachute uses one or two automatic types KAP-3P safety devices and a type 3-1P or 3-3 reserve parachute. With all types of folding, the pack is opened by spring force.

The total parachute set includes: rip cord; extraction line safety cover, extraction line, spherical strapless pilot parachute; stabilizing parachute cover, stabilizing parachute, main canopy cover, main canopy (with lines), suspension system, pack, rip cord ring, safety device (or two devices) KAP-3P, quick-release strap, carrying bag and certificate.

The quick release strap is used only in jumps with forced extraction of the cover with the main canopy by the extraction line. In this case, the following items are eliminated: spherical strapless pilot chute, cover of stabilizing parachute, stabilizing parachute and KAP-3P device.

When jumps are made from the An-2 aircraft with forced extraction of the cover with stabilizing canopy, the pilot parachute and quick release strap are not included.

The KAP-3P device (devices) is included in the set only for jumps with stabilized fall, i.e., when the clamps of the supporting straps of the main canopy cover are enclosed in the ring.

The set includes an extraction ring in all versions.

The extraction line (Figure 7) of the D-1-8 series 6 parachute is designed for forced opening of the parachute, and during jumps with stabilization--to turn on the KAP-3 device. It is made of a capron cord 3 m long. Its tensile strength is 1200 kg. On one end of the line is a hook, on the other end--a loop to which the rip cord is fastened for jumps using a pilot parachute or to which the ring of the cover is attached during jumps with forced extraction of the cover. Halfway down the line is a second loop, to which the cord of the flexible pin of the KAP-3P device is attached for jumps with fall stabilization in the version with the pilot parachute, and to which the loop of the ripcord (always) and cord of the flexible pin are attached (when stabilization is used) in the version with forced withdrawal of the cover.

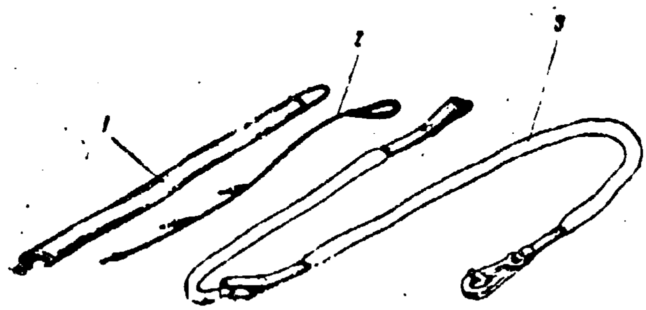

Figure 7. Parts of Forced Opening Device for Parachute Pack: 1, Safety Cover; 2, Rip Cord; 3, Extraction Line

The safety cover of the rip cord (see Figure 7) is designed to protect the skin of the aircraft from being struck by the pins of the rip cord after they are withdrawn from the closure device of the pack. It is made of tent canvas in the shape of a sleeve 990 mm long. It is attached to the loop of the rip cord. When the parachute is folded, the cover is put in place with its "handle" at the loop, and after the ripcord is pulled out of the flexible hose it straightens and covers all the pins.

The rip cord (see Figure 7) is 932 mm long. It carries three pins at separations of 150 mm from each other. The first pin from the pulling loop, which carries a loop for manual opening, is 38 mm long, the other two pins are 32 mm long.

The strapless spherical pilot parachute (Figure 8) consists of a base and spring mechanism which draws the base outward. The upper portion of the base, made of capron fabric, has a hemispherical shape with a midsection area of 0.33 m^2. The lower portion of the base is also hemispherical in shape, going over to a cone. The cone consists of capron fabric, while the remaining portion is made of capron netting with 5 by 5 mm squares. Strengthening bands are sewn over the base, converging at the bottom into a loop.

At the top of the spherical portion is an aperture with a washer, and a cone with a hole for a pin is placed within the top of the conical portion on the lower base of the spring mechanism. The check pin is sewn to a band and attached by it to the upper portion of the base; the pin retainer is also here. The cone, aperture and pin make up the closure device with which the spring mechanism is retained in the closed position. To fold the parachute, the cone is pushed up through the aperture at the top of the parachute and the check pin is inserted. After the flaps of the pack are closed, the spring mechanism is unblocked and the pin is inserted in its retainer.

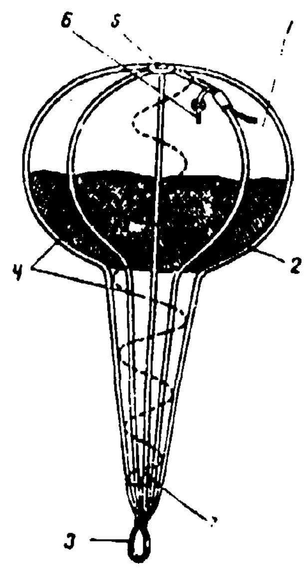

Figure 8. Spherical Pilot Parachute: 1, Upper Portion of Base (Canopy); 2, Screen; 3, Loop; 4, Springs; 5, Top Aperture; 6, Check Pin; 7, Cone

Figure 9. Stabilizing Parachute Cover

Stabilizing cover (Figure 9) is made of viscose fabric in the form of a sleeve, wider at the bottom. The canopy of the stabilizing parachute in the top of the main parachute cover are inserted in the stabilizing parachute. The cover is reinforced with straps over its entire length. The straps in the upper portion of the cover intersect to form a ring, which is attached to the loop of the pilot parachute or the end loop of the extracting line.

Two pairs of permanent loops are sewn to the bottom end of the cover, and there is another pair of removable loops and an apron with two windows. The first zigzag of the stabilizing parachute lines are pulled through the removable loops, which are passed through the windows, thus checking the apron. The remaining portions of the lines are pushed into the permanent loops.

The straps in the loops are covered with a keeper in the shape of a short sleeve. The upper edge of the keeper is attached to the cover above the straps, while its lower edge has three loops. A thread is passed through the loops doubled (made of type SHKHB-125 cord), attaching these three loops to the loop at the top of the cover of the main parachute (this connection prevents the cover from being pulled off the stabilizing parachute too early).

The canopy of the stabilizing parachute (Figure 10) is made of capron fabric and forms a truncated, inverted cone with a base area of 1.5 m^2. At the top, pockets are sewn into the base, improving the filling of the canopy. The canopy is reinforced with capron strips in the circular and meridial directions. Some of the reinforcing strips around the perimeter of the lower edge of the canopy form loops, to which the lines of the stabilizing parachute, each 1300 mm long, are connected. At the bottom, the straps form a loop which is connected to the cover of the main parachute.

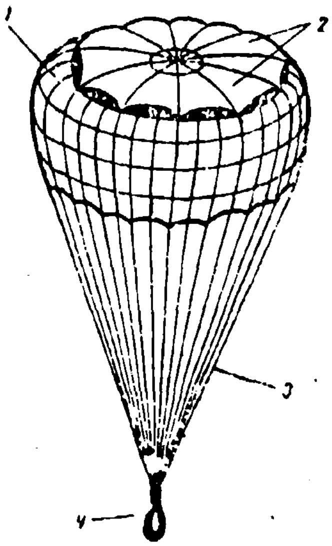

Figure 10. Stabilizing Parachute:
1, Canopy; 2, Pockets; 3, Lines;
4, Loop

The main parachute cover (Figures 5 and 11) consists of percale and is 5.29 m long. Its lower portion, parallel to the two rows of loops, carries two deep, narrow pockets on the sides made of ribbon, into which the folding frame is placed. The loops are made of rubberized cord (pack rubber). The removable loops, used to block the opening of the apron, are made double. Metal strips are sewed around the edge of the windows of the apron to reinforce them. The cover is reinforced with cotton straps over its entire length. The straps in the upper portion are brought together to form a loop, with which the cover is connected to the stabilizing parachute or extraction line. The loop has a protective cover over the actual connection. On the same side of the cover, one half meter from the top edge, is a loop, through which threads are passed to connect it to the loops on the stabilizing parachute strap protector.

On the opposite side of the cover, below the circular band, the reinforcing strips form 125-millimeter free ends with wrapping. The reinforcing strips are sewed to the upper portion of the cover above the reinforcing bands, and a circular strip is wrapped around them.

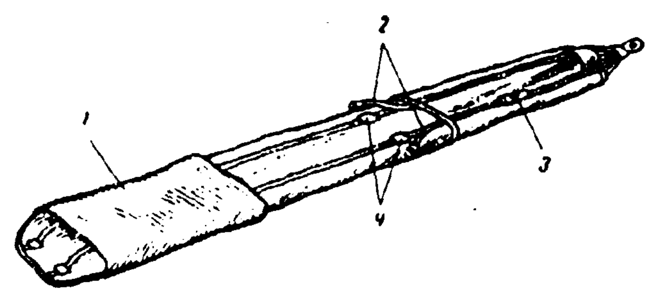

Figure 11. Main Parachute Cover of D-1-8 series 6 Parachute: 1, Line Protector (Dropped); 2, Reinforcing Strips with Wrapped Ends; 3, Closure Device Cone; 4, Retainers

The free ends of the reinforcing strips, passing through the windows in the internal pocket of the pack, into which the lower portion of the cover and main canopy are inserted and placed in the ring on the floor of the pack block the inner pocket of the pack and hold this portion of the cover in it until the stabilization time is passed. In preparing the parachute for a jump without stabilization, the reinforcing lines are placed into two retainers sewed on to the reinforcing strips slightly below the circular strap.

At a distance of 730 mm from the upper edge of the cover, a cone is sewed to the reinforcing strip, blocking the pack when the parachute is folded for a jump with forced extraction of the cover and main canopy.

The main canopy of the D-1-8 series 6 parachute (Figure 12) is made of percale. In plan, it has the shape of a 28-sided polygon with an area of 82.5 m^2. At the center there is an aperture 430 mm in diameter. The canopy consists of four sections, each of which consists of five or six strips (depending on the width of the material used). The first section is located between lines 25 and 4, the second--between lines 4 and 11, etc. The strips in a sector are numbered from the edge of the canopy toward its center. The edges of the canopy are reinforced. The top of the canopy is made in two layers for greater strength. On the outer side of the canopy is a reinforcing frame, forming 28 loops at the lower edge of the canopy, to which the lines are fastened. Between the loops on the canopy are pockets, helping it to open reliably. On the edge of the canopy, to the left of the loop, is the ordinal number of the line, while the label of the manufacturing plant is sewed on to the first strip of the first sector between lines 1 and 28.

The seams connecting canopy sectors are reinforced with strips. The strips form the ring to which the braking strap is attached when a jump is made with forced extraction of the cover.

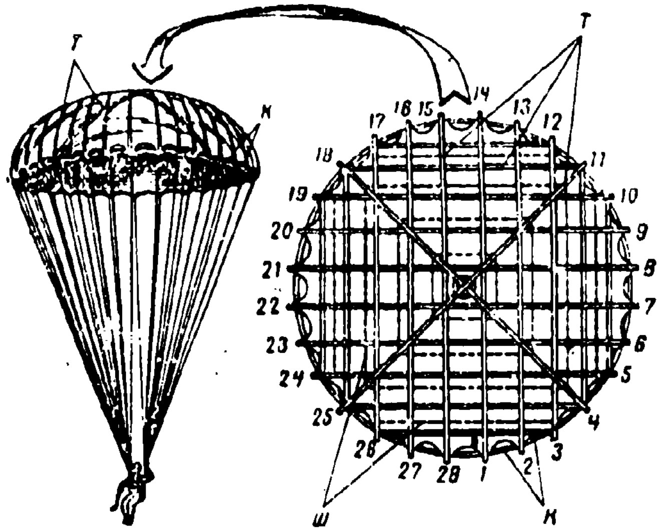

Figure 12. Main Canopy of D-1-8 Parachute:
T, Reinforcing Frame Strips; K, Pockets;
Ш, Seams Connecting Fabric Strips in a Sector

The D-1-8 parachute has 28 straps. They are made of type SHKHB-125 cotton cord and are each 9 m long. Each strap is attached at one end to a loop on the edge of the canopy, at the other end to the rings of the suspension system (seven straps per ring). The end of each connector is connected to its own line.

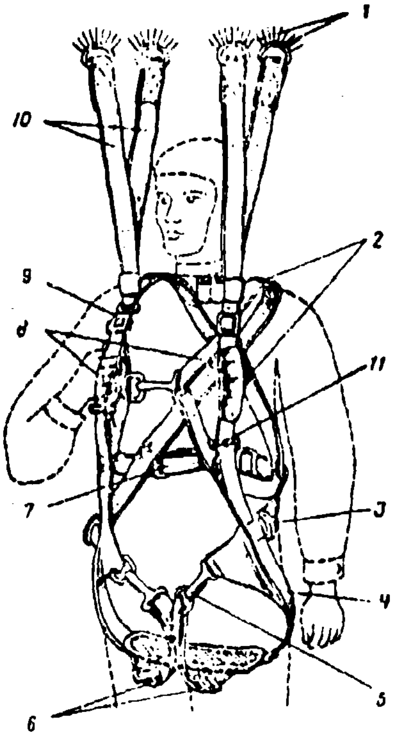

Figure 13. Suspension System of the D-1-8 Series 6 Parachute: 1, Connecting Rings; 2, Back-shoulder Straps; 3, Adjusting (Supporting) Strap Ring; 4, Main Loop; 5, Hook; 6, Leg Straps; 7, Waist Strap; 8, Chest Crosspiece; 9, OSK-D Clamp; 10, Free Ends; 11, Reserve Parachute Mounting Bracket

The suspension system of the D-1-8 series 6 parachute (Figure 13) is made to hold the parachutist comfortably and provide even distribution of the load arising upon operation of the canopy.

It consists of a main strap forming a half loop, on which the parachutist sits while in the air, supplementary parts and four free ends with opening rings. The supplementary parts include: back-shoulder straps, chest crosspiece, waist strap and leg straps, which assure even distribution of loads on the parachutist and hold him in the half loop of the main strap. Using the supplementary parts, by moving the corresponding rectangular rings, the suspension system is adjusted to the size of the parachutist.

The main strap is made of capron, 44 mm wide, double thick, while the other straps are made of the same fabric but are only single thickness. The clamps holding the chest crosspiece and leg straps, as well as all rings and brackets, are made of steel.

The two left free ends are a continuation of the main strap, while the two right (removable) free ends are connected to it through the OSK-D clamp (its body is mounted to the main strap). Using this clamp, the parachutist, after landing, can disconnect the right free ends of the suspension system and rapidly collapse the parachute in case of wind.

Where the main strap divides in half and becomes the left free ends, a retainer is sewed onto it. The flexible hose of the rip cord and the flexible hose of the stabilizer manual opening device pass through this retainer. Below the flexible ring is the rip cord pocket. Still lower in the left and right portions of the main strap there are two brackets at the same level, connecting the intermediate suspension system of the reserve parachute. On the other side, somewhat below the brackets are rings fastening the belts of the equipment container.

The pack is connected to the suspension system where the shoulder-back straps cross and at the center of the waist strap. However, this is not a load-bearing connection. During a jump with stabilization, the main portion of the parachutists weight is transmitted to the pack through special supporting straps which connect the pack and suspension system of the parachutist securely.

A portion of the free ends of the suspension system, the main canopy and lines (in its cover), stabilizing parachute (also preliminary placed in its cover) and pilot parachute are placed in the pack of the D-1-8 series 6 parachute (Figure 14). The stabilizing device clamp, reserve parachute mounting parts, flexible hoses and safety devices are placed on the outside of the pack.

The pack is made of aviation-grade canvas. It has a double bottom, containing a steel rigidity frame. On the outside of the bottom of the pack is a pocket into which the free ends of the suspension system and the lower portion of the cover containing the main canopy and lines are pushed to the level of the load-bearing straps. The upper two corners of the pocket with windows are not sewn together, for ease of folding. Opposite the windows in the flaps there are also two windows in the bottom of the pack, through which the load bearing straps are passed to the outside of the pack, where their rings are hooked by the clamps of the stabilizing device. This design of the upper portion of the pack bottom and its internal pocket assures reliable checking of the pocket and, when jumps are made with the stabilizing parachute, it prevents the lower portion of the cover with the main parachute and lines from leaving the pack too early.

The clamp of the stabilizing device is fastened to the outside of the pack by means of screws. The rings are closed by rotating the clamp counterclockwise. This covers the cones, located on the bottom of the body of the pack, to which the rings of the load-bearing straps are attached. The clamp is opened by rotating the lock to the opposite direction by pulling the line of the extraction ring, the loop of which is seated on the upper cone, or by

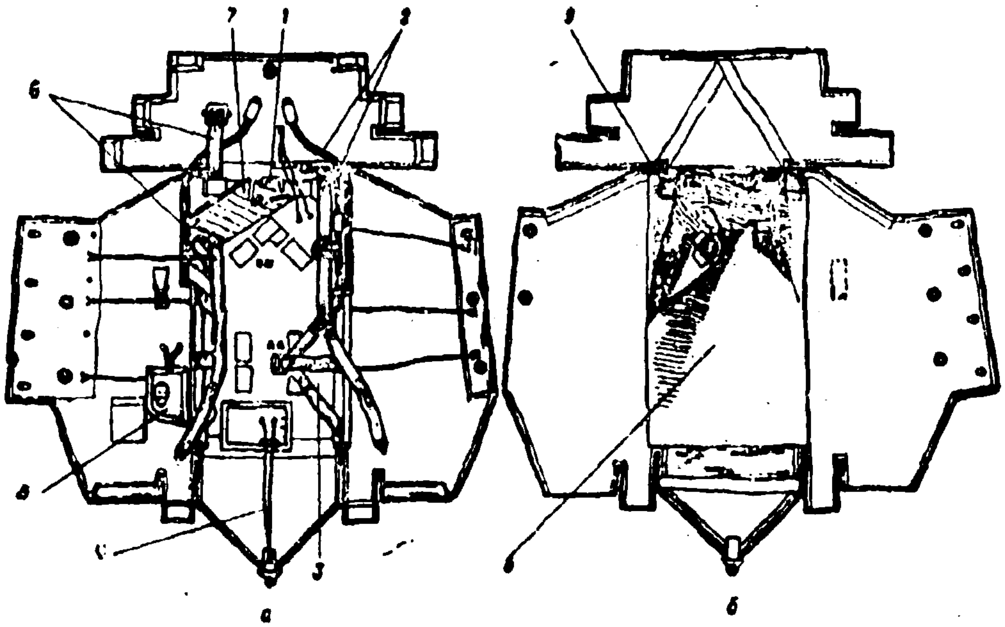

Figure 14. D-1-8 Series 6 Parachute Pack:
a, Outside View; b, Inside View; 1, Stabilizer Device Clamp; 2, Flexible Hoses of Rip Cords; 3, Reserve Parachute Mounting; 4, Pack Rubber Bands; 5, Safety Device Pocket; 6, Stabilizer Device Suspension Straps; 7, Cover Flap; 8, Internal Pocket; 9, Window

means of the line of the safety device, the loop of which is seated on the lower cone of the clamp lock. The clamp is covered with a soft safety flap.

Two pairs of suspension straps are fastened to the windows of the pack. These straps act as an intermediate suspension system for the stabilizing device: the parachutist hangs from these straps during stabilization. The upper pair of straps is designed to support the parachutist during stabilizing fall in a near-vertical position. The ends of these pairs of straps carry toothed rings which are used to connect the pack to the back-shoulder straps.

The lower pair of straps is designed to transmit most of the force of the weight of the parachutist to the pack. Also, these straps are used to regulate the position of the pack on the back. During preparation for jumps with stabilization, before entering the aircraft these straps are tightened and fastened in the rings on the triangular leg clamps. The straps are tightened so that when the canopy of the stabilizing parachute fills, the main pack cannot slide upward and strike the parachutist on the back of the head.

Eight loops are sewed to the outside of the pack floor for attachment of the pack to the suspension system with tie cords. A pocket for the pack certificate is also sewed to the bottom of the pack. A flexible hose carrying the manual clamp opening line is sewed to the bottom of the pack near the stabilizing device clamp and to the left supporting strap.

Two connecting plates with rings are sewed to the lower side portions of the pack, and carry the reserve parachute pack mounting straps.

Wire loops for securing the eight 330-340 mm long pack rubber bands (including the two double bands for the end flaps) are sewed to the bottom of the pack and near the upper portion of the pack flaps on the outside. The rubber bands pass through retainers at the perimeter of the pack bottom.

On the right plate, toward the bottom of the pack, is a pocket for the second safety device. The first device is located in a pocket on the right side flap. There also is a pocket for the hook, and over it a ring to retain the rip cord.

The closure device of the pack consists of five holes, one ring-hole and two cones. The pack is retained closed with the three pins of the rip cord. The second pin is placed in the cone of the spherical pilot parachute, first passed through its hole and the middle hole on the side flaps of the pack. The closure device is covered with a safety flap, which is tightened with four buttons.

Two flexible hoses are fastened to the upper flap of the pack on the outside. The rip cord with its pins, 440 mm long, and the manual opening cord, 515 mm long, are passed through one of these holes.

The top and side flaps have additional flaps with pockets. These additional flaps are guided beneath the side and lower flaps as the pack is closed.

Metal rigidity plates are sewed into the lower and safety flaps, helping the pack to retain its shape.

The double rip cord (Figure 15) is designed for manual opening of the parachute pack and the stabilizer device clamp. The hand ring is steel, trapezoidal in shape. To make it easy to find the ring in the air, the portion of the ring which projects from the pocket is painted red and is bent to conform to the shape of the hand.

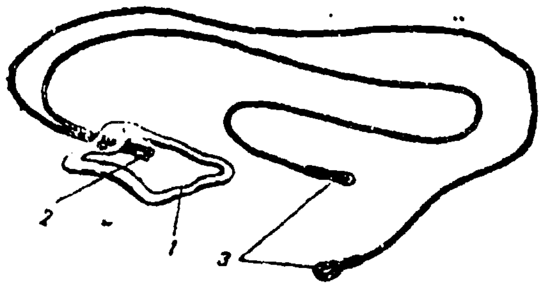

Figure 15. Extractor Ring with Double Rip Cord: 1, Ring; 2, Cord Limiters; 3, Loops

The double cord is fastened into the ring by means of limiters. The opposite end forms loops. The 600 mm cord is designed to open the clamp on the stabilizer device (its loop is seated onto the upper cone of the clamp lock). The 730 mm line is used for emergency opening of the pack during jumps using the spherical pilot parachute (the loop of this line is seated on the upper 38 mm pin of the extraction line).

The KAP-3P safety device is used with the D-1-8 series 6 parachute with 240 mm hose, 397 mm line and 42 mm loop with wrapping. The full length of the flexible pin is 700-750 mm. The device is designed for automatic opening of the stabilizer device clamp if the parachutist for any reason cannot do this by means of the normal rip cord.

If the parachute carries two safety devices for additional reliability, the loop of the second device should not be wrapped and should be 19 mm long. This loop connects the line of the second device to the elongated loop of the first device.

The ends of both hoses are fastened by means of bayonet pins onto the mounting plate of the stabilizer device clamp. Both of the lines with flexible pins are attached to the center loop of the extraction line.

The parameters (time and altitude) are set on the scales of the devices depending on the nature of the jump (mission) at hand.

The quick-release strap prevents the top of the main parachute from being pulled into the cover as it is extracted by the extraction line. Otherwise, the canopy might be tangled with the lines. The quck release strap can withstand the weight of the canopy, and breaks only after all lines have been pulled out and the cover apron is released, when the weight of the parachutist is added to the weight of the canopy. The quick release strap is made of SHKHB-40 cord, is 900 mm long and has a tensile strength of 40 kg.

The carrying bag is used to store and transport the parachute. It is made of aviaton canvas, has two handles for carrying and a device for closing and sealing the bag.

The certificate of the parachute is an inseparable part of the parachute. It carries information on the acceptance, transmission, use and repair of the parachute. Rules for using it are printed on the certificate itself. It is stored in a special pocket on the bottom of the parachute pack.

Interaction of Main Parts of the Parachute as it is Used

We have spoken of the design of the parachute, named its main parts and explained their functions. Let us now study the operation of the parachute in the air and the interactions of its parts, for example for the D-1-8 series 6 parachute with stabilizer parachute, used with the An-2 aircraft (Figure 16).

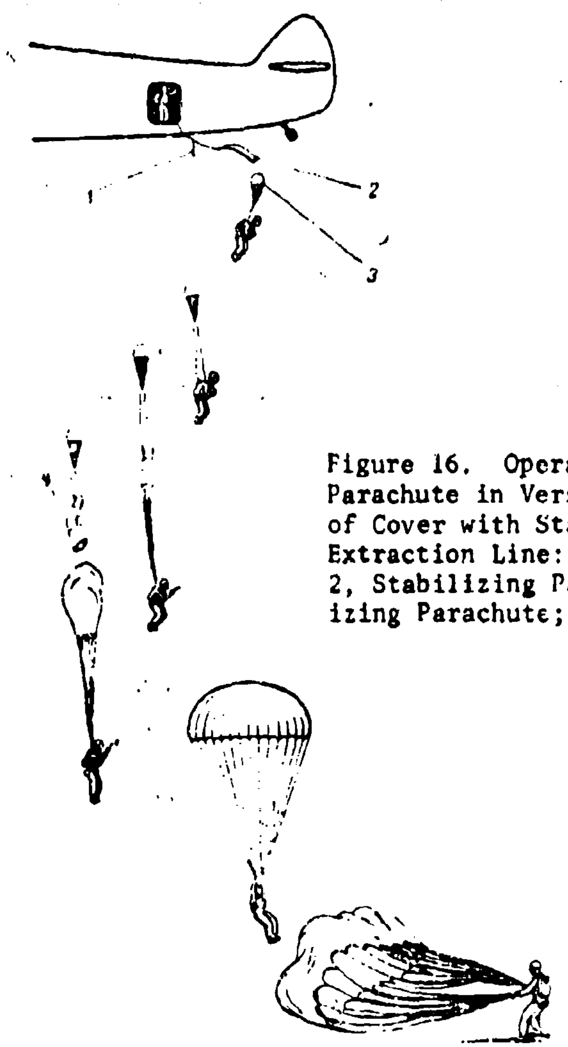

Figure 16. Operation of D-1-8 series 6 Parachute in Version with Forced Extraction of Cover with Stabilizing Parachute by Extraction Line: 1, Protective Cover; 2, Stabilizing Parachute Cover; 3, Stabilizing Parachute; 4, Main Parachute Cover

As the aircraft approaches the drop zone at 140 km/hr, the parachutist begins to prepare himself for his jump. He looks once more at the hook on his extraction line (which must be reliably clamped onto the line in the aircraft). On the command of the jump master, the parachutist jumps out of the aircraft. The process of opening of the parachute begins immediately. The extraction line, with one end attached to the aircraft becomes tight and, breaking the preventer threads, pulls out the flexible pin of the KAP-3P device (the device is turned on); at the same time, this line pulls the rip cord and its pins out of the cones. The cones leave their holes. The pack flaps are pulled back instantly by the pack rubber bands. At the next moment, the extraction line pulls the cover of the stabilizing parachute and, to the extent allowed by the load-bearing straps, pulls out the upper portion of the main parachute cover. This tension breaks the thread connecting the covers of the main and stabilizing parachutes. The lines of the stabilizing parachute are drawn out of the loops, the apron is unblocked, and the canopy of the stabilizing parachute is pulled out of its cover. One second after separation it is fully opened.

The ends of the load bearing straps remain as yet in the clamp ring. During this stage of the process, the opening of the main parachute is delayed. The force of deceleration created by the stabilizing parachute causes the parachutist to turn involuntarily with his legs facing in the direction of motion. A stable fall begins with a speed of up to 35 m/sec.

After the required stabilization time has passed, the parachutist pulls out his rip cord ring (if he does not do this, the safety device operates in a few seconds). The ring clamp of the stabilizing device opens, the load bearing straps are liberated, and the stabilizing parachute begins to extract the cover containing the main parachute from the inside pocket of the pack.

The lines of the main parachute are pulled, come out of the loops, the apron is unblocked and the main parachute canopy is pulled out of the cover. Removal of the cover and opening of the main canopy require 1.5-2 sec.

The further descent of the parachutist is slowed by the main canopy. The cover of the main canopy descends with the stabilizing parachute and falls near the parachutist.

After the landing, if the wind is blowing, the canopy of the parachute lies on the ground but remains filled (does not collapse) and the parachutist may be pulled along the ground. To avoid this, the OSK-D clamp must be opened, by moving the safety button upward to the stop (revealing red signal mark) and, by pressing on both buttons of the slide mechanism simultaneously, moving it to its lower position. The pair of free ends of the suspension system separates from the clamp, the canopy becomes a flag and then falls to the earth.

When jumping with stabilized fall from faster aircraft, the cover carrying the stabilizing parachute is pulled out by the spherical pilot parachute. In this version, after the parachutist leaves the aircraft, the extraction line removes the flexible pin from the safety device and then pulls the rip cord. The flaps of the pack open and the pilot parachute "jumps out" of the pack under the influence of its spring mechanism. Caught by the airstream, it pulls out the top of the cover of the stabilizing parachute. Subsequent operation of the parachute is just as in the previous description, except that the cover of the stabilizing parachute does not remain on the extraction line (on the aircraft) after it is pulled off the parachute, but descends together with the pilot parachute.

In jumps in which the parachute is immediately put in operation without stabilization, when the spherical pilot chute is used but the load bearing lines are not placed in the clamp ring and the internal pocket of the pack is not blocked by them, the pack is forced open (by means of the extraction line) or opened manually (by pulling the rip cord). In this case, the spherical pilot parachute pulls out the cover with the stabilizing parachute. After the stabilizing parachute fills, the main parachute operates as after completion of stabilization.

In jumps with forced pulling of the cover with the main canopy, the pins of the rip cord are pulled from the cones of the locking device by means of the extraction line after the parachutist leaves the aircraft. The line then pulls the cover containing the main parachute out of the pack. The lines are then pulled out of the loops and the cover is unblocked. The weight and force of inertia of the falling parachutist tighten the lines and the tension is transmitted through the canopy to the quick release strap. The quick release strap, which has retained the top of the canopy to this point, is broken and the cover is pulled away from the main canopy. The canopy opens as in all the versions described above.

The operation of the parts of sports and training parachutes with forced extraction of the cover with the main canopy does not differ from that described above. During jumps with forced opening of the pack, the extraction of the rip cord, opening of the pack and opening of the pilot parachute occur just as for landing parachutes during jumps using the spherical pilot parachute. On sports training parachutes there is no stabilizer device and therefore the extraction line is connected directly to the loop on the top of the cover of the main canopy. After extraction of the cover and canopy from the pack by the pull of the pilot parachute, the lines immediately begin pulling out of the loops and the cover is pulled away from the main parachute. Safety devices are not installed on sports training parachutes if forced opening is to be used.

During jumps with sports training parachutes using manual opening, and also during emergency jumps with rescue parachutes, after separation from the aircraft and if the aircraft is left by catapulting, after separation from the catapult seat, the extraction line only pulls the flexible pin out of the safety device (turning on the device). After the required time, the parachutist pulls the rip cord. If he does not do this, at the set altitude the rip cord is pulled by the safety device. The loop of this device is seated over the upper first pin of the rip cord. Further operation of the parts of the parachute is the same as with jumps with forced opening of the pack.

In most sports parachutes with the last two folding methods, a connecting link called a string is placed between the top loop of the main canopy and the loop of its cover. As the cover is removed, it is tightened and retains the top of the canopy from falling through and tangling with the lines (preventing crossing of lines). Also, after the cover is removed the string prevents it from being blown away to the side and being lost.

Folding of Parachutes for Jumping

The purpose of folding of a parachute for jumping is to give all parts of the parachute the proper position to assure safe operation in the air.

Before beginning folding, a place for this must be prepared, so as to protect the parachute from moisture, dust and dirt. It is also desirable to protect the parachute from the direct rays of the sun.

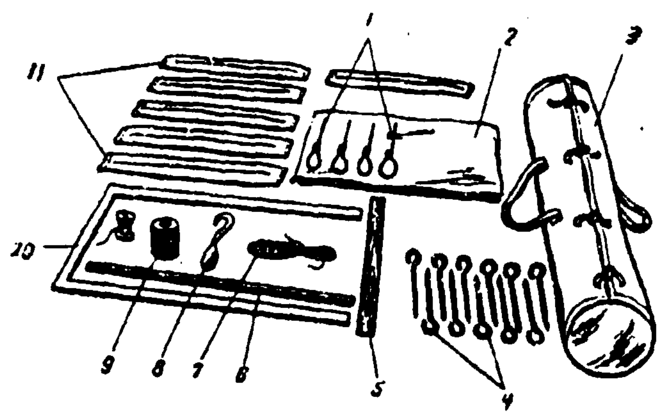

Figure 17. Equipment Used for Folding a Parachute: 1, Pins; 2, White Panel (Folded); 3, Travel Panel (In Carrying Bag); 4, Spikes; 5, Ruler; 6, Pipe; 7, Cord; 8, Hook; 9, Breakable Thread; 10, Frame; 11, Weights

Before beginning packing, the following packing equipment must be made ready in all cases (Figure 17):

--weights (six) consisting of covers with two sections, filled with clean sand;

--metal spikes (11) for fastening of the panels to the earth;

--a well-polished ruler measuring 450x36x6 mm for straightening the pack flaps;

--a metal hook for placement of the lines in the loops;

--supplementary pins for preliminary closing of the pack as the canopy is placed in it;

--a number 15KP capron cord 0.8 m long to facilitate tightening of the pack flaps.

Folding is performed either on a special table measuring 16x1 m with a smooth, waxed surface or on field panels measuring 16x1 m. The top of the table or field panel for the canopy is covered with a white cloth measuring 5.5x1.24 m, to protect the canopy from dirt.

The folding process is divided into six stages. At the completion of each stage, the instructor in charge must check the correctness of the operations performed and give permission for transition to the next stage.

The sequence of stages and operations involved in folding and packing parachutes will be studied using the example of packing of the D-1-8 series 6 parachute for a jump with stabilization when the cover of the stabilizing parachute is to be pulled out by the spherical pilot parachute.

In the first stage, the parachute is inspected and prepared for folding. The parts of the parachute are carefully inspected. If any slight defects are noted, they are immediately eliminated. If the defects cannot be eliminated (parts replacement required), the parachute is taken out of use and sent in for repair. During inspection of the parachute any dirt, grass stubble or other objects which might have been accumulated during assembly or landing are removed.

In addition to the packing equipment mentioned above, it is also necessary to prepare:

--breakable threads (cotton threads of type SHKHB-125 cord), used to tie down the internal pocket of the pack, hold back the clamp of the stabilizing device, the flexible pin of the safety device and the extraction line, and also to connect the cover of the main canopy to the cover of the stabilizing parachute;

--a П-shaped frame to give the lower portion of the cover the necessary rigidity during packing of the lines into the loops;

--a tube for convenient placement of the spherical pilot parachute.

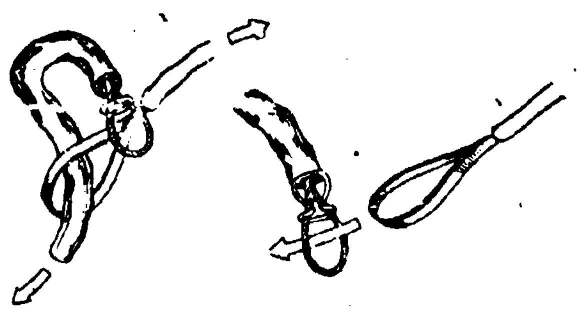

Figure 18. Connection of Retaining Loop

After inspection of all parts of the parachute, it is prepared for packing. Preparation consists in the following: the spherical pilot parachute is fastened to the ring on the cover of the stabilizing parachute with a retaining loop (Figure 18), the stabilizing parachute is fastened by the same type of loop to the ring on the cover of the main parachute (if not already connected). Also, the spherical parachute must be folded into a "pancake." This is done as follows: the packing tube is passed through the aperture at the top of the parachute and placed over the cone; the springs are then compressed so that the cone and tube pass through the top aperture; after this the tube is removed from the cone and the check pin is inserted through the cone.

The parachute pack is placed on the table with suspension system upward and the pack rubber bands are disconnected from the bottom (if they have not already been disconnected). The band hooks should be left on the flaps.

The rip cord handle is placed in the pocket on the main strap of the suspension system and its cords are placed into the flexible hoses of the proper lengths.

The ends of the adjustable suspension strips are placed in the double rings at the triangles of the leg bands. The upper pair of suspension (supporting) strips is fastened to the shoulder-back straps by means of the toothed rings.

The free flexible hose is passed through the retainer on the right chest-back strap and, assembling the protective cover, the rip cord, fastened by the retainer loop to the end of the extraction line, is placed in the cover.

The safety devices are checked according to their operating instructions. The flexible pins with 700-750 mm cords are set in them and the operating altitude and time are set on their scales. The flexible pins are tied with SHKHB-125 cord in one figure eight. The bayonet pins and binding strips of the instruments are used to fasten them onto the mounting plate of the stabilize device clamp. The pin of the hose of the device with the elongated loop is set in the aperture closer to the end of the clamp mounting plate. The slack of the line of each instrument is then adjusted (it should be between 10 and 15 mm) and the loop of the line of the second instrument is connected to the elongated loop of the first instrument (Figure 19). The instruments are placed as follows the first in the pocket on the right flap of the pack, the second in the pocket on the extended flap. The hose of each instrument is fixed in place with a tying strap.

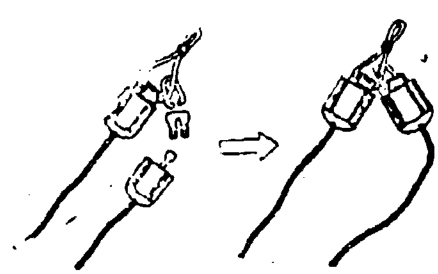

Figure 19. Connection of Loops of Two Safety Devices

After this the pack and support system are turned over, support system downward and placed on the table with the top flap toward the parachute canopy. The free ends of the support system should not be crossed, should be laid out in pairs with the rear free ends upward.

The canopy and lines are stretched out to their full length and the top center loop is connected to the rod at the end of the table. The lines, beginning with the free ends of the suspension system, are divided into right and left groups (untwisted when necessary), and the bottom portion of the canopy is correspondingly divided into two halves. If the canopy is twisted, the center loop is removed from the rod of the table and the canopy is turned until the first strip with the manufacturers symbol is on the top, line 14 is downward. The loop is then once more placed over the rod and the left half of the canopy is thrown over to the right. This completes the first stage of packing.

After checking and the corresponding command, the parachutist begins the second stage, folding of the main canopy.

Two persons are used to fold the parachute--the folder and assistant, and the checking instructor who checks each stage. The sequence of operations during folding is the reverse of the sequence of operation of each individual part of the parachute as it is opened.

The canopy is folded as follows. The loop of line 14, located on the lower edge of the canopy, is placed at the center of the width of the table and the loop of line 15 is placed over it. The edge of the canopy between them is smoothed out, after which the folder folds out the strip between these lines to the entire length of the canopy, while the assistant holds the edge (Figure 20). Then the loop of line 16 is placed over the loop of line 15, the edge and panel are straightened, the loop of line 17 is placed over the loop of line 16 and so forth until the entire left half of the canopy has been laid up. The weights are placed over this half of the canopy and the right half of the canopy is thrown over the left half. The right half of the canopy is laid up in a similar manner. Upon completion of this stage of folding, the panel with the manufacturers mark should be on top. Then, removing the weights, both halves of the canopy are folded over its entire length to the width of the cover (see Figure 5) and the weights are put back on the canopy.

After folding of the canopy, the correctness of division of the lines is checked. The assistant holds the lines at the edge of the canopy, and the folder passes the ruler beneath the upper ends of the suspension system between the lines to the edge of the canopy.

The entire bundle of lines from the free edges of the suspension system to the very edge of the canopy should be divided into upper and lower halves, as well as left and right halves. The fourteenth, check line (which has a recognition mark sewed on, is located in the right group of lines and is connected to the semicircular ring of the front free end of the suspension system as the extreme left line so connected) should be on the bottom, not twisted with the other lines.

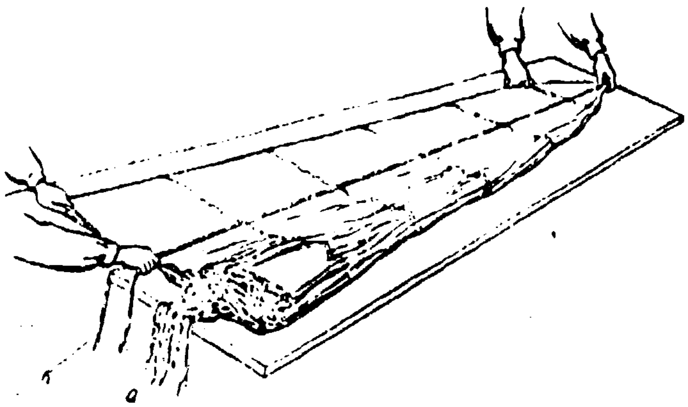

Figure 20. Beginning of Folding of Main Canopy of D-1-8 Parachute: a, Line No. 14; b, Line No. 15

After checking the bundles of straps, they are pulled out, shaken and laid out strap to strap on the table. The cover is placed over the canopy. To do this, the assistant pushes his hand in through the top of the cover and grasps the top of the canopy, the folder takes the cover by the bottom edge of the apron and pulls it down over the canopy to the level of the edge with the loops up, removing the weights from the canopy as he pulls the cover down. The bundle of lines should be located at the center between the groups of loops.

Third stage--placement of lines in cover loops. To do this, the line cover is moved upward and the П-shaped frame is set in the pockets of the cover. Then the edge of the canopy is covered with the cover apron and the lower (removable) loops are passed through the windows of the apron. The entire bundle of lines is grasped at a distance of 0.45 m from the edge of the canopy in the hook and pulled with the hook into the right removable loop so as to form a bend about 5 cm long beyond the loop. The left loop is checked in the same manner. After checking of the apron, the bundle of lines is placed into the loops with the hook in the form of flat zigzags. Beginning with the upper right group of loops, the bundle is pulled into each pair of loops. Between the edge of the canopy and the first, checking loop, and also between checking loops a certain slackness of the bundle of straps should be retained, to avoid early release of the apron (Figure 21).

During packing, one must be sure that the lines do not become twisted. The last 40-50 cm of the lines are not pulled into the loops. After completion of folding of the lines, the П-shaped frame is removed and the line protector is lowered onto the bottom portion of the cover.

Fourth stage--packing of the portion of the cover containing the canopy into the internal pocket of the pack with subsequent preparation of the stabilizing device lock and packing of the stabilizing parachute.

The free ends of the suspension system are pulled to the center and placed on the bottom of the pack so that the straps are located along the pack, the split rings are 350–400 mm from its upper edge. At the same time the lower portion of the cover with the canopy is placed over the straps in the pocket to its entire depth (without twisting the cover) (Figure 22). Then, bending the cover and canopy at the level of the windows of the pack and at the very bottom of the pocket, the portion of the cover with the canopy is inserted into the inner pocket of the pack to the level of the circular strip (to the ends of the load-bearing straps). The cover and canopy should make three layers in the inner pocket of the pack (Figure 23).

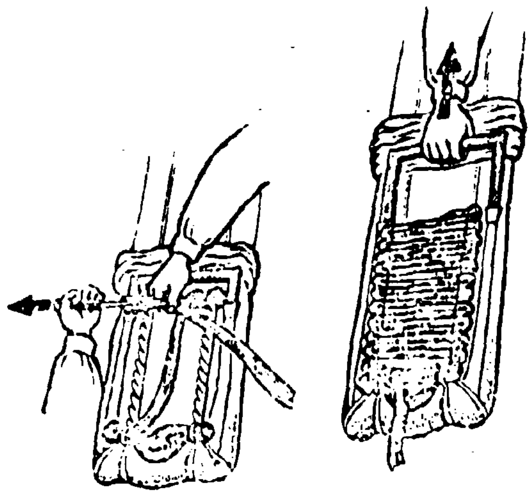

Figure 21. Placement of Lines in Loops of Cover

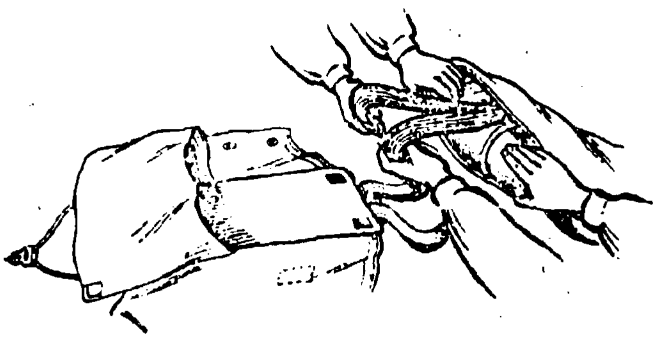

Figure 22. Beginning of Packing of Cover with Main Canopy into Internal Pocket of Pack

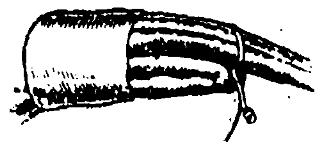

Figure 23. Cover with Canopy in Internal Pocket of Pack

Then, the ends of the load-bearing straps and rings are passed from the inside into the ring windows of the pocket and brought out through the windows on the bottom of the pocket to the outside--to the stabilizing device clamp. To fasten the rings in the clamp, the pack with its filled inner pocket is rotated bottom upward. One must be sure at this time that the load-bearing straps are not crossed and do not fall out of the windows.

The loop of the rip cord is placed over the upper (small) cone of the stabilizing device clamp, the elongated loop of the KAP-3P device is placed over the lower cone; the rings of the load-bearing straps are placed over the cones of the clamp mechanism body (over the large truncated cones) and the clamp mechanism is closed, by rotating it counter clockwise.

A thread of SHKHB-125 (one thickness) is passed through the apertures in the upper portion of the clamp mechanism and, by tying its ends together, the clamp is blocked closed. After this the pack is rotated back so that the suspension system is downward.

Half of the remaining portion of the cover and main canopy, folding at the level of the ends of the bottom of the pack, is placed over the inner pocket and packing of the stabilizing parachute is begun.

The canopy of the stabilizing parachute is usually not specially folded. It is simply grabbed by the peak, held up and shaken, so that the lines and panels are located symmetrically relative to the vertical axis of the parachute. The lines are checked: they should not be twisted or crossed, any line should separate freely from the bundle when pulled to one side.

After checking the lines, the cover is pulled over the canopy of the stabilizing parachute and the lines are placed in the loops of the cover (the technology of this operation is similar to the technology of placement of the main canopy in the cover and pulling of its lines into the loops, except that the П-shaped frame is not used). The strap protector is then lowered and 0.5 m of the upper portion of the cover of the main canopy is placed into it--down to the level of the loop. A thread (of SHKHB-125 cord) is passed through this loop and the three loops on the line protector of the stabilizing parachute and, holding the loops toward each other slightly, the ends are tied together (Figure 24).

Then the remaining portion of the cover is placed in the pack with the main canopy so that four layers are formed above the pocket. The cover with the stabilizing parachute canopy is placed over the last layer, covering the entire area, and the folded pilot parachute is placed over this. The pin in the cone of the pilot parachute should lie along the length of the pack, with its ring toward the lower flap of the pack.

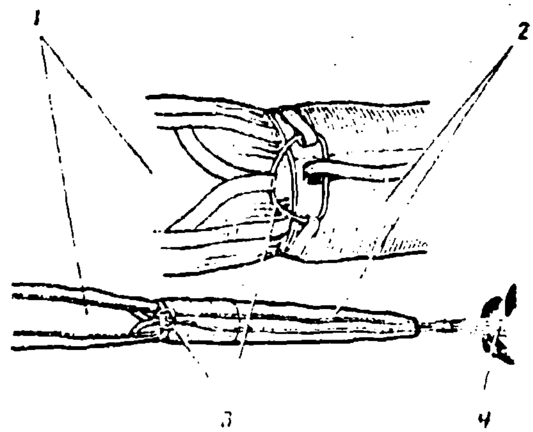

Figure 24. Connection of Main Canopy Cover to Stabilizing Parachute Cover: 1, Cover with Main Canopy; 2, Cover with Stabilizing Parachute Canopy; 3, Breakaway Thread; 4, Spherical Pilot Parachute

Fifth stage--tightening of pack over central cone (Figure 25). The middle hole of the left side flap of the pack is pulled tight over the cone of the pilot parachute, the check pin is pulled out and pulled into its loop, then the supplementary pin is inserted in its place after the flap is pulled over the cone. After this, the middle hole of the right side flap is pulled over the cone over the left flap, the supplementary pin is removed and reinserted above both flaps.

Sixth stage--final tightening of the pack. Using the other supplementary pin, the top flap of the pack is pulled tight, by placing the top holes of both side flaps over its cone. The first pin of the rip cord is placed over both of these holes in the top cone, after first passing it through the loop of the rip cord. The second pin of the rip cord is inserted in the cone of the pilot parachute, after removing the supplementary pin.

Then the lower hole on the right side flap is placed over the lower cone on the left side flap and a supplementary pin is inserted. Then the lower flap of the pack is closed. To help in this operation, the folder takes the ruler by both ends and places it over the side flaps of the pack at the level of the lower cone. The helper grabs the ring hole of the lower flap and pulls it up toward the cone. At the same time, the folder pulls the ruler beneath the lower flap in the direction from the cone toward the base of the flap (Figure 26). The ruler is then removed, the hole is pulled over the cone, the supplementary pin is removed from the cone and replaced with the last pin of the rip cord, over both holes.

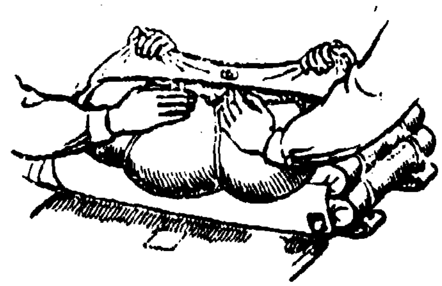

Figure 25. Beginning of Tightening of Pack

This completes packing of the parachute into the pack. It remains only to push the secondary flaps into the pack with the ruler, to pull tight and hook the pack rubber bands and to tighten the safety flap of the closure device. One must be sure that the hooks are carefully clamped into the wire loops on the flaps, that the rubber bands pass through the retainers around the perimeter of the bottom of the pack and through the apertures beneath the base of the flaps. Attention should be also given to see that the right bands pass beneath the hoses of the safety devices, that the top bands pass beneath the rip cord line. The insertion of the extracion line beneath the rubber bands on the pack is then begun.

The unit which connects the extraction line with the cord in the end of the flexible hose is guided between the upper and right side flaps. The extraction line is placed in a zigzag shape beneath the upper and lower rubber bands of the right flap. The middle loop of the line is tied with a breaking thread (of SHKIIB-125 material) in one thickness to the ring on the flap of the pack, and the end of the cord of the flexible pin of the safety device is attached to the loop itself (if two devices are installed on the parachute, both cords are attached).

The snap hook of the extraction line is placed in a special pocket on the right flap of the pack beside the pocket for the safety devices.

This sixth and final stage completes packing of the parachute. The packing equipment and closure device are then checked. After being sure that everything is in order, the parachute is placed in its carrying bag, sealed and the corresponding entries are made on the certificate.

Packing of the D-1-8 series 6 parachute for a jump with immediate opening (without stabilization) using the spherical pilot parachute is performed in the same sequence as for a jump with stabilization, but with the following changes:

--installation of the safety device is eliminated;

--before placing the cover over the main canopy, the ends of the load-bearing lines with loops are placed in their retainers, sowed onto the canopy cover;

--after packing the lower portion of the cover with the canopy into the inner pocket of the pack, the windows are attached to the windows of the bottom of the pack by breaking thread in two passes;

--the flexible pin is not tied to the loop of the extraction line.

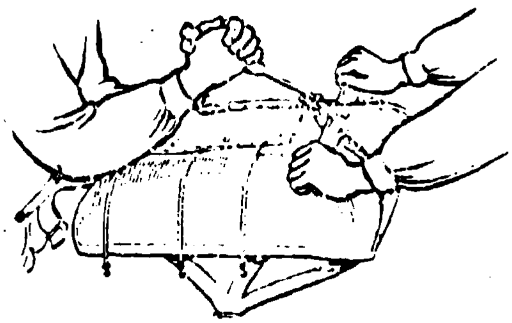

Figure 26. Tightening of Last (Lower) Flap of Pack

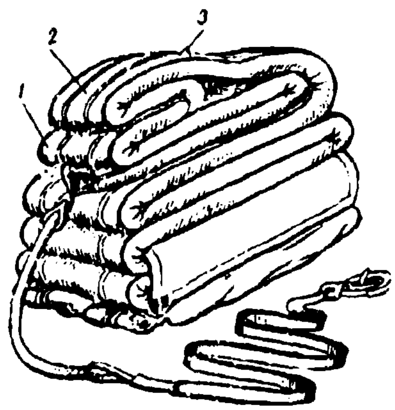

Figure 27. Packing of Covers with Canopies in Pack in Version with Forced Extraction of Cover with Stabilizing Parachute by Extraction Line: 1, Stabilizing Parachute Cover; 2, Main Parachute Cover; 3, Central Cone

If the parachute is packed for a jump with stabilization of fall with forced extraction of the cover with the stabilizing canopy (without using the spherical pilot parachute), as the parachute is prepared for packing, only the spherical pilot parachute is eliminated from the set. The rip cord is attached to the central loop of the extraction line, while the loop on the cover of the stabilizing parachute is attached to the end loop.

The parachute in this version is packed the same as in the first version, with the following differences:

--the covers with the main and stabilizing canopies are placed in the pack as shown on Figure 27;

--the central holes of the side flaps of the pack are placed over the cone of the main canopy cover;

--the loop of the rip cord is left free (not placed on the first pin of the extraction line);

--the end of the flexible hose with the extraction line is directed between the upper and right side flaps, while the connectors joining the extraction line to the cover and extraction cover to the cord are left outside.

When the D-1-8 series 6 parachute is packed for a jump with forced extraction of the cover with the main canopy by the extraction line, the pilot and stabilizing parachutes are eliminated, as well as the safety devices; the end of the extraction line is connected to the loop on the cover of the main canopy, its middle loop is connected to the loop on the rip cord. Before placing the cover on the canopy, the ends of the load-bearing lines are placed in the retainers, and the top loop of the canopy is connected to the breaking line. After the canopy is placed in the cover, the other end of the breaking line is tied both to the canopy cover loop and to the end loop of the extraction line.

Placement of the cover with the canopy in the pack and blocking of the internal pocket of the pack with breaking thread are performed the same as in the version with immediate opening of the main canopy (without stabilization), while tightening of the pack is the same as in the version with stabilization without the spherical pilot parachute.

With all version of packing, the loop of the rip cord is connected to the clamp on the stabilizing device ring. This avoids the possibility that the parachutist will hang from the aircraft if the loops of the load-bearing lines are connected to the clamp of the stabilizing device by mistake. This type of error can occur only with careless packing of the parachute for a jump with forced extraction of the cover with the main canopy.

Sports-training parachutes for jumps with forced extraction of the cover with the main canopy are packed similarly. The rip cord handle is not installed in this case.

For jumps with forced opening of the pack, the sports parachute includes a pilot parachute and an emergency rip cord handle. The pilot parachute in this packing version is attached to the central loop of the main canopy cover, while the loop of the rip cord is placed over the first pin of the forced opening line (before the pin is inserted in the locking device). After opening of the pack in the airstream, the cover is pulled out with the main canopy by means of the pilot parachute.

In the version of packing of sports-training parachutes for jumps with manual opening, the rip cord ring is used in place of the extraction line, with pins on the rip cord which hold the rings onto the cones of the packs, and with the safety device. The loop of the device is placed over the first pin of the line, while the end of the flexible hose is mounted on a special plate on the pack flap. The extraction line is used to activate the device (the line on the flexible pin of the device is attached to the end loop of the extraction line). Otherwise, this packing version does not differ from the version with forced opening of the pack.

Rescue parachutes are packed only for manual opening and, as a rule, with safety devices installed in them.

Packing of a reserve parachute is also divided into six stages. Let us discuss these using the Z-2 series 2 or Z-3 reserve parachute.

First stage--preparatory.

The working location and necessary packing equipment are prepared, the parachute is carefully inspected. The canopy and lines, pack, rip cord and ring, carrying bag should be in good condition and clean. The pins of the rip cord are passed through the pack hoses, and the rip cord handle is set in the pocket on the pack flap.

The canopy is fastened down by hooking the top loop over the rod at the end of the table and drawn out to its full length. The lines are also extended. The intermediate suspension system is placed on the table so that the loop is next to the table, the free ends are parallel to each other and the circles are turned toward the canopy.

Second stage--packing of the canopy.

The canopy is packed in the same manner as the canopy of the D-1-8 parachute. The control line (which has a recognition collar sewn around it, is in the right group of lines and is connected to the semicircular ring of the lower free end as the extreme left line) should be on the bottom, the panel with the plant insignia should be on the top.

The second stage is completed upon checking of the position of the lines (divided over their entire length according to the free ends into four parts which must not overlap and must not be twisted). After this the loop at the top of the canopy is removed from the rod at the head of the table.

Third stage--packing of lines.

The pack is placed with loops upward and the flaps are bent beneath it. The intermediate suspension system is placed on the pack so that the straps with which the reserve parachute is connected to the suspension system of the main parachute are located over the windows in the upper flap of the pack, while the crosspiece is located between the base of the flap and the loops.

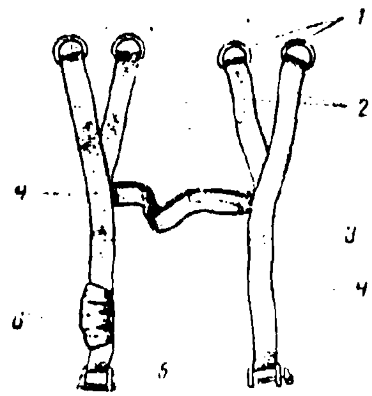

Figure 28. Intermediate Suspension System of Reserve Parachute: 1, Semicircular Rings; 2, Free Ends; 3, Cross-Piece; 4, Straps; 5, Mounting Brackets; 6, Pocket for Rip Cord Handle of Main Parachute

If the reserve parachute is used in combination with a main parachute, the suspension system of which does not include special brackets for attachment of reserve parachute straps, the crosspiece must be placed at the base of the upper pack flap. In this case, the excess of the center portion of the crosspiece is passed through the central loop and into the retainer on the bottom of the pack. The bend in the bundle of straps in the left pair of free ends 5-6 cm from the semicircular rings is pulled with the hook through the lower left loop in the direction from the edge toward the center of the bottom of the pack; the bundle of lines in the right pair is correspondingly pulled through the right lower loop. After this, the lines are connected into a single bundle and, bending it over the upper opening in the pack, it is pulled first into the middle, then into the left upper loop. Further placement of the lines in the loops is performed by the ordinary method: the hook is placed alternately into the right and left loops, forming flat zigzags. The remainder of the lines (1.2-1.4 m) is placed on top is a zigzag.

If the reserve parachute is used in combination with a main parachute, the suspension system of which has brackets for attachment of the reserve parachute straps, the intermediate suspension system (Figure 28) is laid on the pack so that the crosspiece is at the base of the lower pack flap. The mounting brackets are reserved from the intermediate suspension system of the reserve parachute in this case.

On the crosspiece, along the lower opening of the pack bottom, first the left, then the right pair of free ends are laid out against each other, bending them by 90° relative to the direction of the straps and bending them around their longitudinal axis by 180°. The bend in the bundle of lines of the left pair of free ends is pulled into the lower right loop and in the direction from the center of the bottom of the pack toward the side, while the bend in the bundle of lines of the right pair is correspondingly pulled through the left lower loop.

Further operations involved in packing the lines and their sequence in the version of placement of the reserve parachute with short straps are the same as those operations described above in packing the lines of a reserve parachute in the version with long straps.

Fourth stage--packing of canopy onto bottom of pack.

The canopy is placed onto the bottom of the pack so that the lower edge of the canopy is at the base of the upper flap. Then, bending the canopy over the lower and upper edges of the upper flap. Then, bending the canopy over the lower and upper edges of the bottom of the pack alternately, it is folded into zigzags equal in length to the length of the pack. The top portion of the canopy with the extraction device pockets should be on top, and the pockets themselves should not extend beyond the bend in the canopy, be twisted or bent inward.

Fifth stage--tightening of upper and lower flaps.

The canopy is pressed downward by hand and the top flap of the pack is pulled over it. The bottom flap is placed over the top flap. Then the upper and lower flaps are pulled, the left hole of the lower flap is placed over the left cone of the upper flap and the pin is pushed through the aperture of the cone.

After this, the pack is tightened over the second cone.

Sixth stage--final.

First the left, then the right side flaps are tightened, using the pins from the rip cord to replace the packing pins.

After all flaps are tightened, the packing ruler is used to straighten out the pack and align the flaps.

The final pin of the rip cord is sealed using No. 40 thread, glue and a small piece of paper, on which the person responsible for packing writes the date and his signature.

The safety flaps and pack rubber bands are installed. The last stage of packing is completed by filling out the certificate of the parachute.

Basic Rules for Operation and Storage of Parachutes

Parachutes packed for jumps must be stored sealed. If storage is to be for less than 15 days, the pack rubber bands can be left tight. Before putting on the parachute (or before the parachute is installed in a pilot's ejection chair), it must be carefully inspected. The seal on the parachute and the packing date are checked. External inspection is used to determine the presence, good condition and correctness of installation of all parts; the ease of movement of the pins in the cones, correctness of installation of parachute safety devices, adjustment of the suspension system and position of the OSK (or OSK-D) clamps are checked.

If a main parachute is prepared for jumping, the suspension system of which has brackets for mounting of a reserve parachute, it is used in combination with a reserve parachute with short straps. The mounting brackets must be removed from its strap loops.

Before the suspension systems of the main and reserve parachutes are connected together, the parachutist puts on the main parachute and connects the snap hooks of the chest crosspiece and leg straps (the snap hook spring should be turned toward the body of the parachutist).

The reserve parachute is mounted in the following sequence:

--the snap hooks mounting the reserve parachute (located on straps mounted on rings or ribs of the main parachute pack) are snapped over the half rings on the bottom of the reserve parachute pack; the mounting straps of the reserve parachute pack are adjusted to tighten it against the parachutists body;

--the loop of the left strap of the intermediate suspension system of the reserve parachute is pushed up between the sides of the left bracket yoke; the pin of the bracket is passed through this loop (Figure 29); pressing on the head of the pin, it is rotated one quarter turn until the lugs enter the recesses on the opposite side of the yoke;

--the right strap of the intermediate suspension system is similarly connected to the right mounting bracket of the reserve parachute.

If a main parachute is used, the suspension system of which does not have reserve parachute mounting brackets, it must be used in combination with a reserve parachute with long straps. In this case, the suspension systems are connected before the parachute is put on using the brackets in the loops of the straps of the reserve parachute (Figure 30). The pin of the mounting bracket passes through the center loop of the bend shoulder ring on one side and all loops pass through this ring on the other side. The pin retaining snaps must be turned toward the inside and pressed tightly against the body of the bracket after the pins are screwed in.

The parachutist puts on the parachute set thus assembled with the help of his assistant. The sequence is as follows: the parachutist takes the reserve parachute, the helper takes the main parachute and they lift them upward. The parachutist then passes his head up between the straps of the reserve parachute and, lowering it slightly and holding it up alternately with the left and right hand, he places first his left arm, then his right arm through the back-shoulder straps on either side.

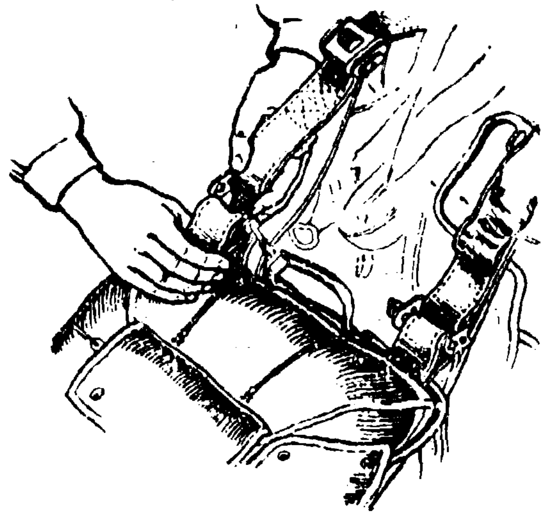

Figure 29. Connection of Suspension Systems of Main and Reserve Parachutes in the Version when the Mounting Brackets of the Reserve Parachute are Installed on the Suspension System of the Main Parachute

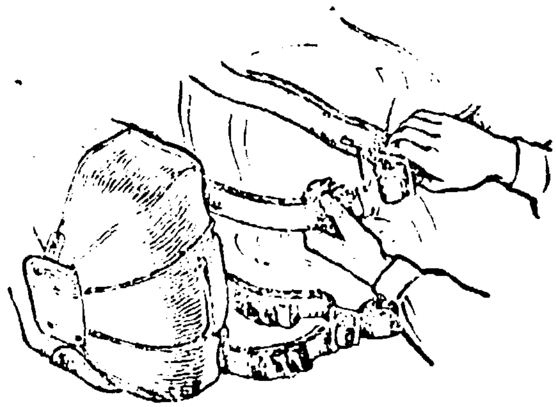

Figure 30. Connection of Suspension Systems of Main and Reserve Parachutes in the Version in which the Suspension System of the Main Parachute does not Include Reserve Parachute Mounting Brackets

After snapping all snap hooks on the suspension system, the pack of the reserve parachute is attached to the snap hooks by means of the straps, which are then adjusted to tighten against the body of the parachutist.

All parts of the parachute, connecting brackets and placement of parts and instruments are carefully inspected after the parachute has been put on but before entering the aircraft.

After completing a jump, the parachutist takes off the suspension system and disconnects the reserve parachute. He then takes the canopy by the top loop, pulls it out to its entire length and shakes it, to remove foreign objects (grass stems and dirt). He rolls the canopy up into a roll, then winds the lines up in a slipping (continuous) loop in the direction from the canopy to the suspension system (Figure 31). The rubber bands are unhooked from the base of the pack and the flaps are straightened.

After this, the parachutist places the equipment in the carrying bag in the following sequence. The pack is set at the center of the bag against the rib, its inside turned toward the side of the bag to which the upper flap is sewn. Then the canopy, rolled cover and lines are placed between the inside of the pack and the side of the bag, and the reserve parachute and suspension system with all metal parts are placed in the other section of the bag. The spherical pilot parachute is folded and placed on top, then the bag is closed.

If the parachute falls into dirty or sea water, it is washed in clean fresh water, then hung up to dry without being wrung out. Parachutes used for landing on snow are also hung up to dry. In the winter, they are hung up in rooms, in summer--in the open air, but out of direct sunlight. Parachutes must be carefully dried. If even slightly wet, parachutes are packed and then used later in low temperatures, the textile materials may freeze together, preventing the canopy from opening. Storage of moist parachutes in warm weather can cause the appearance of mold on cotton parts, reducing their strength.

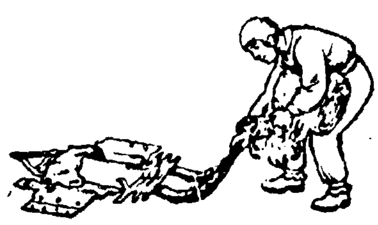

Figure 31. Assembly of Parachute After Landing

Benzine or non-ethyl gasoline can be used to remove dirt and spots from a parachute. Chemical stains are removed by cutting out the damaged sector and sewing in a patch.

Parachutes must be stored in a dry, well-ventilated area, where the relative humidity is between 40 and 70%, the temperature between 0 and +30°C. They must be protected from direct exposure to sunlight.

Parachutes should be stored in special cabinets or on shelves one deep at least 50 cm from the walls and the ceiling, at least 1 m from heating devices. There must be a minimum of 20 cm between the bottom shelf and the floor.

Parachutes must not be stored near paints, fuels and lubricants, acids, alkalis or substances which liberate corrosive gasses, or near metal objects which may rust.

Parachute devices can be stored together with parachutes or separately, depending on the necessity of using them.

When parachutes are transported, in order to protect them from damage and dirt, they must be covered with canvas. Bags of parachutes must be placed not over four high and also covered with canvas.

At the loading point, parachutes are placed on field tables or canvas ground covers (not over two high) and protected from sunlight and moisture.

In preparing a parachute for extended storage, it is aired out, the full set of equipment is put together, the canopy is folded by panels, placed in the bag, as in assembly before a jump, and the bag is sealed.

Parachutes in storage are periodically unfolded and dried. The times between refolding and drying, like the service lives of parachutes, are determined by the instructions for folding and use for each type of parachute individually.

All uses, refoldings, dryings and repairs of parachutes, as well as transmission of a parachute from one organization to another and assignment to a parachutist or team (group) member must be recorded on the certificate with the parachute.

Parachute Instruments

Parachute are equipped with special instruments which assure jump safety or help the parachutist to orient himself in the air.

To supply the jumper with oxygen during jumps from high altitudes, parachute oxygen devices are used (KP-23, KP-27, etc.). As a safety device in case the parachutist or pilot performing a forced evacuation for some reason cannot open his parachute himself, various types of KAP-3 devices or the PPK-2P device are used, as well as the PPD-10 new device for training parachutes.

Sports parachutists use the SM-16 stopwatch to count off free fall time during jumps with delayed opening of the parachute, and the miniaturized VP altimeter to determine their altitude.

The parachute oxygen device (Figure 32) in assembled form is a flat duralumin box with two hoses, a nipple sealed with a plug and a viewing window. Within the box is a battery of series-connected cylinders, a capillary tube wound into a spiral and a manometer. The cylinders are filled with oxygen through the nipple to a pressure of 150 atm. The pressure in the device is checked through the viewing window by the manometer. In the operating position, oxygen from the cylinders through the capillary tube and open stop valve of the switch is fed into the long hose of the device and through it into the hose of the oxygen mask. The second (short) hose is disconnected at the moment, and its opening is covered by a back valve. The capillary tube slows the oxygen feed rate. Due to this tube, the oxygen is fed into the mask in a continuous stream, creating normal pressure for breathing throughout the entire time of operation of the device (15 minutes).

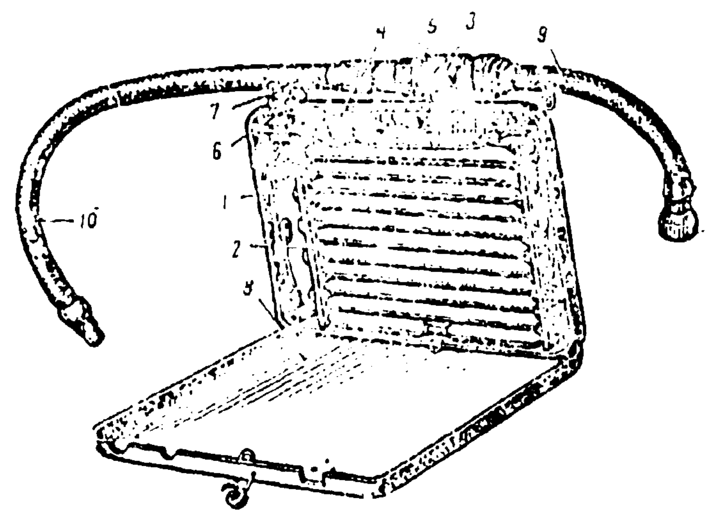

Figure 32. KP-23 Parachute Oxygen Device: 1, Base of Device; 2, Battery of Cylinders; 3, Switch with Stop-Start Valve; 4, MK-14M Oxygen Manometer; 5, Capillary Tube; 6, Charging Nipple; 7, Plug; 8, Cover Device; 9, Hose (0.25 m); 10, Hose (0.7 m)

The shafts of both valves of the switch are connected by a matching lever so that when one valve is open, the second is closed and vice verse. When the short hose is inserted into the switch it presses with its shaft onto the back valve and holds it in the open position--the stop valve is closed. The short hose is held in the switch by means of a blocking device consisting of cones, holes and pins. The ends of the pins are connected together and attached to a snap hook.

In the aircraft, the snap hook is attached to one wall of the aircraft, while the second end of the short hose is connected to the aircraft oxygen supply. Thus, oxygen from the aircraft oxygen system can be used in flight.

Upon leaving the aircraft, the pins are pulled out of the cones, the short hose is disconnected from the switch and its end is covered with the back valve. At the same time, the stop valve is opened and the device begins operating.

Parachutes designed to carry the oxygen device have a special pocket with ties on the bottom of the pack. The device is inserted in the pocket so that the short hose is turned toward the hose of the onboard oxygen supply in position in the aircraft.

When the oxygen device is mounted on the parachute, one must be sure that the position of the hoses does not interfere with normal operation of the free ends of the suspension system of the parachute as it is opened.

The parachute safety device is a sort of mechanical hand which helps the parachutist if needed. The device automatically pulls the pins from the cones of the closure device of the pack and also opens the clamp of the stabilizing device if the parachutist for any reason does not pull the rip cord. The operating springs of safety devices provide a pull of at least 28 kg.

The most commonly used safety devices are the KAP-3 of various modifications (Figures 33 and 34) and the PPK-2P, similar in design and external appearance but differing in technical characteristics, used for rescue parachutes. These devices have a combined memory unit consisting of interacting clock and barometer mechanisms. The operating springs are blocked by the clock mechanism for two to five seconds. In turn, the clock mechanism can be blocked by the aneroid barometer mechanism.

The devices are prepared for use as follows.

By rotating the screw adjusting the position of the aneroid box, the mechanism is set to the altitude at which the device should operate. This screw is connected to a plate carrying the altitude scale divisions. Rotating the screw therefore adjusts the desired scale division beneath the pointer (this operation is referred to as setting of the altitude of the device).

The flexible pin is then inserted in the device, blocking the anchor wheel of the clockwork mechanism. A special bracket or cord is used to tighten the line of the puller device to the click stop, compressing the working springs and blocking the clockwork mechanism.

After this the flexible line is pulled out and, turning the device with the viewing windows downward, the operation of its clockwork mechanism is tested. When the pin is pulled out of the device, the anchor wheel is freed and the clockwork mechanism begins to operate under the influence of the main spring, indicated by the easily audible clicking.

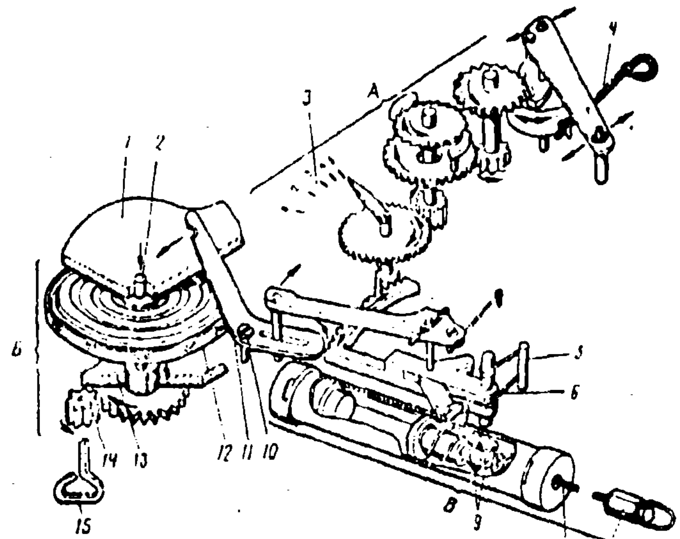

Figure 33. Diagram of KAP-3 Device: A, Clockwork Mechanism; B, Aneroid Mechanism; C, Puller Device; 1, Top Plate; 2, Shaft; 3, Timescale; 4, Flexible Pin; 5, 6, Return Springs; 7, Connecting Unit; 8, Line; 9, Main (Working) Spiral Springs; 10, Blocking Lever Shaft; 11, Blocking Lever; 12, Altitude Scale; 13, Lower Plate; 14, Setting Gear; 15, Setting Key

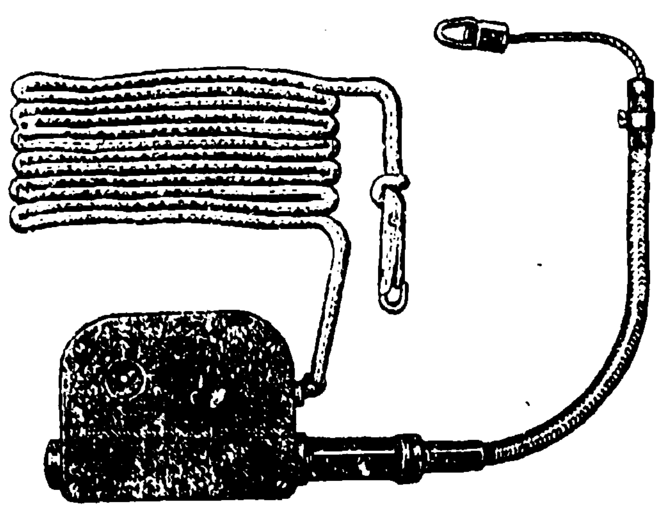

Figure 34. Overall View of KAP-3 Device with Flexible Line and Snap Hook Used when Device is Used on Rescue Parachutes

Just as in an alarm clock at the time set a spring is released and a bell is sounded, in the parachute safety device the operating springs are released and the rip cord is pulled rapidly into the hose.

If the clockwork mechanism is operating properly and no metal powder, sand or other foreign objects can be seen through the viewing window, the time is set.

In order to set the needle opposite the desired time scale division, the flexible pin is once more inserted into the device, and the main spring is wound up. Then, by removing the pin and immediately reinserting it several times, the clockwork mechanism is allowed to run off the extra time, i.e., the device is set on the desired time. After this the pin is blocked by tying it in position with a loop of SHKHB-125 cord (Figure 35).

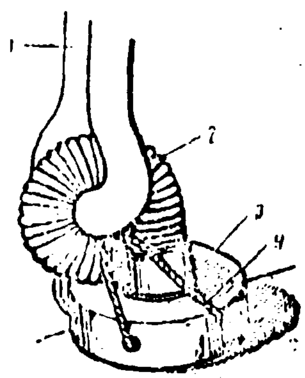

Figure 35. Blocking of Flexible Pin of Automatic Parachute Safety Device: 1, Cord; 2, Flexible Pin Loop; 3, Device for Breaking Thread

For a forced jump of jump with delayed opening of the parachute, both the altitude and time are entered in the device: it "orders" the parachute not to be opened below a fixed altitude, but in no case any earlier than a fixed time.

For a jump with stabilization not over 5 seconds, the altitude on the device is set at 4000 m--clearly higher than the altitude at which the jump will be made, i.e., in effect the aneroid mechanism is disconnected, while the needle of the clockwork mechanism is set opposite the division with the figure 5. If two devices are set, the first device (with the long loop) is set at 5 sec, the second device is set for somewhat longer time. The line connecting the flexible pin of the first device to the extraction line is also somewhat shorter than the line of the second device. This prevents simultaneous operation of the devices and protects the long loop of the first device from excessive load.

After this preparation, the devices are installed on the parachutes.

If defects are found in the parts of the extraction device (breaking of parts of the cord, wear of braiding on hose, wear of line loop, scratches on the special or tail nut, etc.), or if the hose and cord must be replaced by longer or shorter items, the device may be partially dissembled.

To avoid accidents due to possible expansion of the power springs, the device must be dissembled in the following strict sequence:

--flexible pin 24 (Figure 36) is inserted into special hole 25 in the body of the device and the power springs are wound;

--special bolt 16 with loop 17 is removed from special nut 15;

--the winding key supplied with the device is unscrewed from special nut 15 of collar 19;

--collar 19 and special nut 15 are removed from the cord;

--cap 1 is removed with the wrench supplied with the device, after which the insert is removed and clamp 2 with spring 3 is removed from the guide tubes;

--a smooth metal rod 14-15 mm in diameter and at least 100 mm long is inserted in the tube until it presses against the piston; to avoid ejecting the rod from the tube when the device operates, its free end is pushed firmly against the surface of a table;

--flexible pin 24 is removed from the body and the device is allowed to operate;

--after operation of the device, gradually releasing the force on the metal rod, it is moved away from the spring;

--piston 5 is removed from the tube together with line 11 and spiral springs 8 and 9;

--screw 7 is removed from the piston, then plug 6 is removed, followed by line 11;

--coupling nut 21 of the hose is removed from guide tube 22; after this counter nut 20 is loosened and bushing 10 is unscrewed, using the wrenches supplied with the device.

The parts are replaced as required from the spare parts set supplied with the device.

The extractor device is assembled in the following order:

--line 11 is rubbed with a rag soaked in type OKB-122-3 oil (No. 3 oil) and passed through the end aperture into piston 5; plug 6 is set in the same aperture and held there with screw 7;

--bushing 10 is set into coupling nut 21, then counter nut 20 is screwed on;

--bushing 10 is screwed into tip 12 of hose 13, which is blocked with counter nut 20; the coupling nut should rotate freely on the bushing of the tip;

--the thread of guide tube 22 is lubricated with No. 3 oil, after which coupling nut 21 is screwed on;

--spiral springs 8 and 9, roller 23 and its shaft, as well as the friction surface of the piston are lubricated with No. 3 oil, after which the springs and line with the piston are set in tube 22;

--flexible pin 24 is set into special bushing 25 in the body of the device;

--a smooth metal rod 14-15 mm in diameter is pressed against piston 5, forcing it into tube 22 until power springs 8 and 9 are compressed so that roller 23 of piston 5 clicks behind lever 4 (to do this, the metal rod is rested against the surfaoe of the table, and the body of the device is pressed downward, forcing the rod inward and compressing the spring);

--spring 3 is inserted in tube 22 with clamp 2, cap 1 is placed and tightened over the clamp;

--special nut 15 and collar 19 are placed over line 11, the collar is screwed into the nut, then loop 17 is passed into the slots of special screw 16, which is then screwed into nut 15.

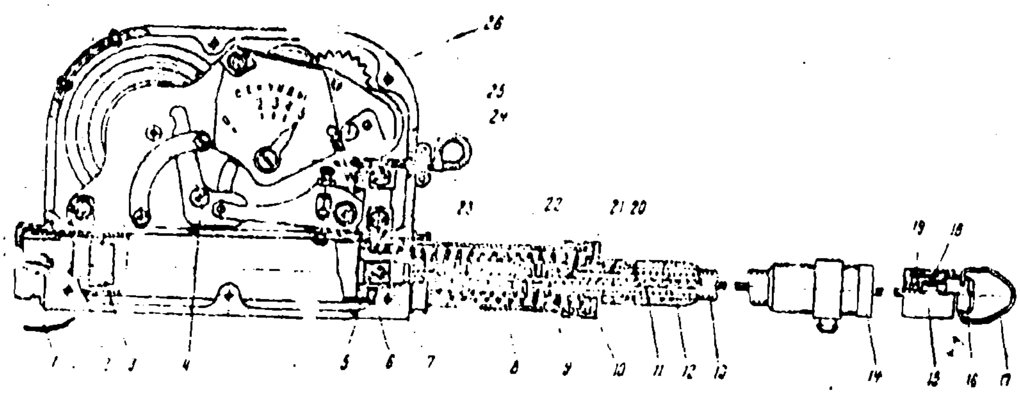

Figure 36. Overall View of KAP-3 Device with Cover Removed: 1, Cap; 2, Clamp; 3, Spring; 4, Blocking Lever; 5, Piston; 6, Plug; 7, Screw; 8, Inner Spiral Spring; 9, Outer Spiral Spring; 10, Bushing; 11, Line; 12, Hose Tip; 13, Hose; 14, Threaded Bushing Tip; 15, Special Nut; 16, Special Screw; 17, Loop; 18, Line Tip; 19, Clamp; 20, Counter Nut; 21, Coupling Nut; 22, Guide Tube; 23, Roller; 24, Flexible Pin; 25, Special Bushing; 26, Body of Device

After the device is assembled, one must check to see whether its clockwork mechanism operates smoothly. This is done by removing the flexible pin and observing the motion of the needle. The mechanism should operate without stopping or jerking. After the device operates, special nut 15 should not reach tip 14 of the threaded bushing.

When a jump is made, the device is switched on by pulling out the flexible pin with the rip cord as the parachutist jumps out of the aircraft (or the pilot leaves the catapult seat). If this occurs at an altitude equal to or less than the altitude set in the aneroid mechanism, the device will operate after the clockwork mechanism counts off the required time. If the jump altitude is significantly higher than the altitude set on the aneroid box, the box will expand and its shaft will project beyond the surface of the upper plate. The blocking lever of the clockwork mechanism, moving over the plate, will stop when it strikes the projecting shaft and the clockwork mechanism will stop, without reaching the end of its set time. The clockwork mechanism will be then held in this position until the fixed altitude is reached, where the atmospheric pressure compresses the aneroid box. As the box is compressed, the shaft disappears beneath the surface of the plate and allows the blocking lever to continue moving; the clockwork mechanism will the tick off the remaining second, releasing the power springs, and th device w ll operate.

The parachute altimeter is an aneroid barometer. Its scale is calibrated not in units of pressure, but in units of altitude coresponding to this pressure (in tens of meters and in kilometers).

The operating principle of the device is based on the dependence between elastic deformation of the sensing element (aneroid box) and atmospheric pressure. The aneroid box is connected through a system of gears to the needle which indicates the altitude. The maximum measurable altitude is 5000 m. The dimensions of the device are 56x56x23 mm, weight 80 g.

The device is fastened to the upper flap of the reserve parachute by means of the pack rubber bands, or together with the stopwatch to a special instrument panel mounted on the reserve parachute, also by means of the rubber bands.

Theoretical Principles of Parachute Jumping

Let us study the forces acting on a jumper during a parachute jump.

According to the universal law of gravity, all bodies attract each other. Therefore, any body suspended over the earth is acted upon by the force of gravity

$$P=mg$$

where m is the mass of the body; g is the acceleration of the force of terrestrial gravitation, 9.81 m/sec ^{2}

If the body begins moving freely toward the earth, it will increase its velocity each second. However, the velocity will not increase by 9.81 m/sec^2, but rather somewhat less. This is why: As soon as the body begins to move, i.e., accumulates some velocity, air resistance appears.

The force of this resistance depends on the shape of the body, its greatest cross-sectional area in the plane perpendicular to the onrushing airstream (midsection area), the density of the air and the rate of motion of the body:

$$Q = C_x S \rho \frac{V^2}{2}, \quad (1)$$

where Q is the air resistance;
C_x is the drag factor for body shape factor;
S is the midsection area;
ρ is the mass density of the air;
V is the velocity of motion of the body.

As wind tunnel tests have shown, the minimum drag factor (0.05) is that o a drop-shaped form, while the maximum (1.42) is that of a hemispherical form.

The direction of motion of the body or, more precisely, the direction from which the air stream reaches the body, is important. For example, if a parachutist is falling with his parachute not open (referred to as free fall) with his body horizontal, face downward with arms and legs spread, his drag factor is 0.6-0.7. The same parachutist falling with his body at an angle of 45° to the horizontal has a drag factor of 0.2-0.4. Another example. When the airstream strikes a hemispherical body on the concave side the drag is maximal, while when the airstream strikes the same body on the convex side the drag factor decreases to 0.34.

The mass density of the air (mass of the air per unit volume) changes as a function of pressure and temperature of the air. As the pressure increases, the density of the air increases (and vice verse), as the temperature increases the density decreases (and vice verse). The density decreases with increasing altitude (pressure decreases).

For specific conditions, the mass density of air is determined from special tables or can be approximately calculated using the formula

$$\rho=0.047\ \frac{B}{T}\left(\frac{kg/sec^2}{m^4}\right)$$

where B is the air pressure in mm Hg;
T is the absolute temperature of the air

$$T=273°C+t°C,$$

where t°C is the air temperature in degrees Celcius.

Under normal conditions (pressure 760 mm Hg, temperature 15°C) $\rho=0.125\ kG\cdot sec^2/m^4$, or $1.225\ kg/m^3$, which amounts to the same thing, since

$$1.225\ kg=\frac{1.225\ kG}{g}=\frac{1.225\ kG}{9.81\frac{m}{sec^2}}=0.125\ kG\cdot sec^2/m^*.$$

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*One should not confuse a kG of force with a kg of mass. The same body, having the same mass, will have one weight at the north pole, and another, slightly lower weight at the equator, and a still lower weight on the surface of the moon.

At 5000 m above sea level

$$\rho = 0.074\text{-}0.075\ \frac{kG \cdot sec^2}{m^4}$$

The mass density for tropospheric altitudes (up to 10-12 thousand meters) can be determined with good accuracy using the Vetchinkin formula:

$$\frac{\rho_H}{\rho_0} = \frac{20-H}{20+H}, \text{ from which } \rho_H = \frac{\rho_0(20-H)}{20+H}$$

where ρ_H is the density of the altitude in question;

ρ_0 is the density of air at the surface of the earth;

H is the altitude in km.

As concerns the rate of fall of a body, it increases under the influence of the force of gravity or the weight of the body. However, the weight of the body does not change (its mass and the acceleration of terrestrial gravitation are in this case constant quantities). But the drag of the air does increase. And it increases much more rapidly than velocity increases. For example, if velocity is doubled, drag is quadrupled. Consequently, a moment arises when these forces are equal (Q=P). Since these forces are directed in opposite directions, they balance each other. However, the body does not stop in this case. To stop it, it would be necessary to apply a drag force greater than the force of gravity to the body. Only this would cause the body to slow down. But in this case, where Q=P, only further increases in velocity stop, the body reaches the so-called critical (termina') speed.

The critical speed in m/sec can be determined from formula (1) by performing the required conversions. If at the critical speed Q=P, then

$$P = C_x S \rho \frac{V_{cr}^2}{2}, \text{ from which } V_{cr} = \sqrt{2P/C_x S \rho} \qquad (2)$$

Since the density of the air increases with decreasing altitude, while the body enters the denser layers of air at a speed equal to the critical speed for a less dense layer, the drag also increases continually. Therefore, after the critical velocity is reached, the falling body begins to slow down and its velocity is gradually decreased.

The velocity reached by a body falling through the atmosphere at the end of a certain sector of time depends on many variables and it is difficult to calculate it using formulas for each second of fall. It is also difficult to calculate the distance traveled by a body in this sector of time. It is still more complex to describe mathematically the fall of jumpers, since each man has a different drag factor, changing also depending on the position of the jumpers body.

Therefore, in practice with jumps from altitudes of up to 2000 m with delays of opening of not over 11 sec, simpler, empirical formulas are used:

$$V_f = gt - 0.46t^2 \quad \text{and} \quad \Delta H = \frac{gt^2}{2} - 0.15t^3$$

where V_f is the approximate rate of fall of the jumper in m/sec at the end of a given second;

ΔH is the approximate loss of altitude in m in a falling time of t sec;

0.46 and 0.15 are coefficients selected experimentally.

In calculating jumps from great altitudes with great delays, special tables must be used.

The critical velocity of a parachutist after a free fall of 1000 m is usually 50 m/sec. This speed is reached after approximately 10-11 sec following separation from the aircraft and changes little as the jumper approaches the earth. Of course, free fall can continue only to a certain altitude, after which the critical speed must be decreased to the safe speed. How is this done?

Analyzing formula (2) we can easily conclude that we must either decrease the numerator by 100 times or increase the denominator of the expression beneath the radical by the same factor. However, the numerator contains only the weight of the parachute, and it cannot be decreased by this factor, while ρ in the denominator also cannot be increased (we have already noted what determines the mass density of the air). Only C_x and S remain. It is these quantities which are sharply increased as the parachute is opened.

What physical phenomenon occurs when a parachute opens?

After the lines leave the loops in the cover of the main canopy and the cover itself leaves the canopy, the canopy, extended to full length is in a high velocity airstream. A portion of this stream flows beneath the edge of the canopy and, finding no exit, is decelerated. According to Bernoulli's law, the pressure in this portion of the stream increases, becoming significantly greater than the pressure in the surrounding stream. Under the influence of this extra pressure, the canopy begins to expand from within and straighten (begins to fill). The drag factor C_x, midsection area S and, consequently, drag Q increase sharply. The jumper is rapidly decelerated.

The increase in force Q is perceived by the parachutist as a shock (and the phenomenon is called dynamic opening shock). The decrease in velocity will continue until the critical velocity is reached for the new C_x and S and the drag is balanced by the force of gravity. A slight additional decrease in velocity also occurs. However, it is hardly noticeable, since it results only from the change in mass density ρ, which increases slowly as altitude decreases.

If the parachute opened instantly, the increased drag (opening shock force) would be very great. During the early stages of development of parachutes, when covers were not used, to say nothing of stabilizing parachutes, jumps with delayed opening of the parachute created such great deceleration that quite healthy, physically strong jumpers suffered "brown out."

Now, since the advent of covers, pilot and stabilizing parachutes, C_x and S increase more slowly and the opening shock is painless, even following high free fall speeds.

Let us analyze why this occurs.

In the formula

$$Q=P+ma=P(1+\frac{V_f-C_d}{gt}),$$

where Q is the force of opening shock;

P is the weight of the jumper in kG;

m is his mass (T/g);

a is the mean value of negative acceleration, i.e., the deceleration of the rate of fall in m/sec^2, equal to

$$\frac{V_f-V_d}{t}$$

where t is the time over which the speed is decreased from V_f to V_d (from the moment of beginning of opening of the parachute to the moment of establishment of the new critical speed or descent speed of the parachutist).

Consequently, the longer the process of opening of the parachute, the longer the time over which the speed is decreased, the less the value of ma and the less the force of the opening shock.

After opening, an uncontrolled parachute is fully at the mercy of air currents. If there is no wind, it descends vertically. However, this is very rare. There usually is some movement of the air mass and the parachute, carried along with this movement, carries the parachutist in whichever direction the wind is blowing. However, since the parachutist is vitally interested in where he lands, he should plan his jump in advance, before he takes off in the airplane. This planning consists of determining a point in air space where he should leave the aircraft and the point where the parachute should be opened so that the eind will carry the parachutist from that point, the opening point of the parachute, to the desired landing spot on the ground[1].

The following methods are used for calculation of jumps:
--arithmetic method, using pilot balloon data;
--graphic method, using pilot balloon data;
--visual method, using sighting parachute.

Pilot balloon data are the windspeed (in m/sec) and directions for various altitudes determined using pilot balloons launched from the landing area or somewhere nearby.

The arithmetic jump planning method consists of the following. All values of windspeeds at various altitudes are added right up to the altitude at which the parachute is to be opened and the sum produced is divided by the number of quantities added. The result is the mean windspeed

$$u_{av}=\frac{u_{H_1}+u_{H_2}+u_{H_3}+\ldots+u_{H_n}}{n},$$

where n is the number of components.

If the assigned parachute opening altitude H_p and mean descent speed V_d are known, the descent time $t_d=H_p/V_d$ from which altitude can be determined. The drift of the parachutist is then determined, i.e., the distance on the terrain between the epicenter of opening of the parachute (the point on the terrain over which the parachute is opened) and the landing point of the parachutist

$$L=u_{av}\cdot t_d$$

where L is the drift of the parachutist.

After this, all meteorological wind directions (directions from which the wind blows) are added and, dividing this sum by n, the mean meteorological wind direction (MWD) is determined. The mean MWD is the direction from the desired landing point to the epicenter of opening of the parachute and, if jumps are made without delayed opening of the parachute, the direction of arrival of the aircraft (DAA)

[1]With controlled parachutes, which have some horizontal velocity component of their own, the error in calculation can be corrected by maneuvering horizontally.

$$DAA = \frac{MWD_1 + MWD_2 + MWD_3 + \ldots + MWD_n}{n}\text{*}$$

The most precise results in this case are produced if the data for the various altitudes change little. If the changes are great (it may occur that the wind is blowing in one direction at the surface, in the opposite direction higher up), then the graphic method should be used.

The graphic method of planning a jump consists in the following. The landing point is drawn on a sheet of paper and a line (meridian) is drawn through it. A line is drawn from the landing point showing the direction of the wind in the surface (first) layer and the drift of the parachute in this layer is laid out on this line in some scale:

$$L_1 = \frac{u_{H_1}}{t_1}$$

Then, from the end of the sector thus produced, the drift in the second layer is calculated and laid out in the same scale, followed by the drift for the third layer, etc., right up to the assigned opening altitude. A straight line is drawn through the ends of the broken line thus produced. The angle between the meridian and the straight line sector connecting the ends of the broken line will be the DAA, while this sector will in itself represent the total drift of the parachutist (in scale). The advantage of this method is its clarity: the approximate trajectory of motion of the parachutist is drawn in plan.

The visual method of jump planning using a sighting parachute is the most precise. To do this, a sighting parachute is released by an aircraft flying at the assigned opening height and precisely over the center of the landing area; the rate of descent of the sighting parachute must be approximately the same as the average rate of descent of the parachutists. After it lands, the aircraft is directed over a straight line in the direction from the landing point of the sighting parachute to the center of the landing area (circle). The flight time of the aircraft over the distance between these points is measured. Without changing the direction and speed of the aircraft, the pilot continues beyond the center of the landing area for the same flying time. The end point of this distance will be the calculated parachute opening point.

Calculations using a sighting parachute can be performed when the windspeed is not too great and when one can be sure that the sighting parachute will land somewhere on the landing area or nearby. Therefore, sighting

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*The direction of arrival is not always the course of the aircraft, since there may be a side wind at the jumping altitude and the pilot may have to make a correction for drift angle in order to maintain the DAA.

parachutes are most frequently [illegible] for the actual planning, but rather to check and refine calculations made by some other method.

When jumps are made with considerable delay of opening of the parachute, and also when jumps are made with long fall stabilization, when the opening point of the parachute does not correspond to the point where the parachutist leaves the aircraft, the separation point must be calculated along with the parachute opening point. The arithmetic or graphic method is used for this purpose, but in place of V_d, the mean free fall velocity of the parachutist V_{ab} must be used while V_d is replaced by the fall time from the separating height to the parachute opening height t_{II}. The direction of arrival of the aircraft and its flight time following the center of the landing area to the jump point are selected with the correction for the drift of the parachutist over the time of his fall. If calculation and jumping are performed properly, and the weather has not changed, a parachute with neutral canopy (canopy without slits, stabilizers or other projections used to make it controlable) will deposit the parachutist at the calculated point.

If the parachutist sees that he is being carried away from the planned point, he can change the trajectory of his motion, forcing the canopy to slip in the desired direction. Slipping is achieved by pulling the free end straps of the suspension system. The canopy is tilted in the direction of the straps pulled. As a result of this, more air slips from beneath the edge of the opposite side of the canopy per unit time; since any gas flow causes a reaction force in the opposite direction, it forces the canopy to move in the direction of the edge which is pulled downward.

Slipping is also used to avoid approaching other parachutists in the air during descent, to refine calculations, and also to reduce the force with which the legs strike the earth if a landing must be made in a wind.

Let us study the final stage of a parachute jump--the landing.

Let us assume arbitrarily that the entire mass of the parachutist is concentrated at his center of gravity (cg) somewhere at the center of his body. Then at the moment of beginning of the landing (when just the bottom of his boots have contacted the blades of grass at the point of the landing, but have not crushed the grass yet), his kinetic energy will be equal to $mV_d^2/2$, his potential energy will be mgh_{b1}, where h_{b1} is the altitude of the cg of the parachutist over the surface of the earth at the beginning of the process of landing. At the end of landing, when V_d is equal to zero (full stop), his kinetic energy will also be equal to zero, while the potential energy decreases to mgh_{e1}, where h_{e1} is the height of the cg of the parachutist over the surface of the earth at the end of the landing. The remaining energy is expended in work A, which the parachutist performs during $h_{b1}-h_{e1}$, by acting on the surface of the earth with force F over the time of the process of landing.

The amount of this work $A = (\frac{mV_d^2}{2} + mgh_{b1}) - mgh_{e1} = \frac{mV_d^2}{2} + mg(h_{b1} - h_{e1})$. Since this work, divided by the path length over which it is expended, is a force, while $m=P/g$, the force with which the parachutist acts on the ground $F = \frac{A}{h_{b1}-h_{e1}} = \frac{PV_d^2}{2g(h_{b1}-h_{e1})} + P$, or since $V_d/2=V_{av}$ over the sector from h_{b1} to h_{e1}, while $V_{av}=(h_{b1}-h_{e1}/t_T)$, where t_T is the deceleration time from V_d to 0, the force of this action

$$F = \frac{PV_d \cdot V_{av}}{h_{b1}-h_{e1}} + P = \frac{PV_d}{gt_T} + P = P(\frac{V_d}{gt_T} + 1).$$

Yet this same force (any action has an equal and opposite reaction) is expended by the ground on the parachutist. The effect of this force on the parachutist is perceived by him as a quite perceptible shock. Therefore, the parachutist, analyzing the last formula, seeks methods to decrease F.

His own weight P, to which this weight is directly proportional, cannot be greatly reduced. There is no method to decrease the landing speed as well; it can only be prevented from increases (increases can be caused by tilting of the canopy by excessive, careless use of the straps or control lines).

During a wind, when we must use not V_d, but rather the resulting landing speed $V_1=\sqrt{V_d^2+u^2}$, where u is the wind speed at the surface, the parachutist can decrease this resulting speed somewhat by pulling on the straps and causing the canopy to slip in the direction opposite to the wind. The impact against the earth in this type of landing will be somewhat less than the impact which would occur with the same wind but without pulling on the rear straps.

The parachutist can decrease force F also by increasing the deceleration distance $(h_{b1}-h_{e1})$ or the deceleration time t_d. The distance can be increased by increasing h_{b1} or decreasing h_{e1}. The altitude of the cg at the beginning of landing can be increased by stretching out the legs (but not too much, as we will note below) and by landing in footwear with thick soles.

If the soles of the boots are soft, they also help to decrease h_{e1} during landing. The value of h_{e1} is decreased primarily by deeply bending the knees. However, it is still better if a landing parachutist does not attempt to remain standing, but rather falls down (but not on his back!). In this case, his In this case, his cg at the end of the landing is as close as possible to the surface of the earth (h_{e1}=min) and, with otherwise equivalent conditions, the denominator in the formula will be maximal, while F=min. This is one reason why it is recommended to parachutists that they not attempt to remain on their feet when landing, but rather fall forward or to one side.

As concerns the deceleration times, they increase together with increasing deceleration distance. This is facilitated by the elastic resistance of the muscles of the parachutist (primarily the quadriceps or "football players muscles" and glutaeal muscles), and also be sliding of the parachutist along the surface in case of a landing in wind (thus increasing the total deceleration distance).

Analyzing the formulas, we can draw the following conclusion.

The landing shock can be decreased if the time of its application is increased, i.e., if the movement of the parachutist is decelerated over a longer time, over a greater distance.

How can this be achieved? First of all, at the beginning of the landing the parachutist should hold his legs slightly (at about 150°) bent at the knees and hips.

It would seem that the more the legs are extended, the longer will be the landing distance $h_{bl}-h_{el}$ and the less the force of the impact. Up to a certain point this is true. But then, due to the excessive reduction in the distance from the line of action of the force to the bending point (to the joint), the bending moment is decreased (the product of the force by this distance) to the extent that the legs, particularly if they are extended precisely along the trajectory of motion or near it, cannot be bent at the moment of contact. The parachutist lands with his legs straight. This type of landing is quite dangerous, particularly if the angles in the joints are 180° or even more. In this case, the time of damping of the speed and the deceleration distance are sharply decreased, thus increasing the force of the shock. This type of landing usually results in injury to the legs, most frequently to the knees, and is quite painful.

The best position of the legs is such that the velocity vector and trajectory of motion of the cg of the parachutist passed through the centers of the areas of the ankles, shins and thighs (Figure 37). In this case, in addition the muscles mentioned above, the gastrocnemius and back muscles can provide elastic resistance (the muscles should be moderately tense before the landing).

The breaking distance cannot be increased by bending the toes downward. In this position, the load is first accepted by the bones of the feet, which are very thin and relatively weak. It is particularly dangerous to land with the toes extended with a cross wind, or with the legs in a position such that the trajectory of movement of the cg of the parachutist passes over the feet. The toes may be easily bent and injured.

Figure 37. Proper Preparation of Parachutist for Landing: cg, Center of Gravity; V_d, Vertical and V_h, Horizontal Components of Landing Velocity V_l

It is also not recommended to land on the heels, since excessive loads are transmitted to the muscles of the tibia.

It is most correct to hold the feet parallel to the surface of the earth, so that they contact flat.

It is dangerous to spread the legs before landing. The feet may contact different heights and too much of the shock may be transmitted to one leg. This type of landing may cause injury. Furthermore, if the ground is approached while moving sideways, one leg may strike the other at the moment of landing. Therefore, in all cases before landing the legs should be tightly pressed together, allowing their position to be controlled.

Finally, before landing the parachutist should always turn to face in the direction he is drifting (face downwind). If the landing is made while drifting backward, there is danger of striking the back of the head on the ground. If the ground is approached while drifting sideways, the legs are bent and twisted upon landing, possibly resulting in injury.

All of this requires that a parachutist practice his actions using trainers until they become automatic before ever making a parachute jump.

Physical Training of the Parachutist

Parachute jumping, particularly for beginning parachutists, involved significant loadings on the organism.

Sports parachutists should have the endurance of a runner, the reactions of a basketball player, the strength of a boxer, the flexibility and coordination of an acrobat.

Anyone who plans to jump or who has begun jumping should perform physical exercises each morning. Here is a suggested set of exercises.

Number	Name and Brief Description of Exercise	Duration (Number of Repetitions)
1	Breathing From the standing position, legs spread to shoulder width, raise the arms upward and forward with palms inward (while rising onto the toes)--inhale, lower the hands and arms and lean slightly forward--exhale, then return to initial position.	4-8 times
2	Running (usually with free breathing, then lifting the knees high and deep breathing)	
3	Pulling arms backward* Starting in the standing position, feet at shoulder width; A--arms bent before the chest, palms downward, elbows to the side--two jerks (exhale) arms to the side, palms downward or upward--two jerks (inhale);	4 times
	B--arms bent before the chest--two jerks (inhale), left arm straight downward, right arm straight upward, hands in a fist--two jerks (exhale), arms bent before the chest--two jerks (inhale), right arm straight down, left arm straight up, hands in fists--two jerks (exhale);	4 times
	C--left arm straight downward, right arm straight upward--jerk, change position of arms--jerk (free breathing)	16 times

Number	Name and Brief Description of Exercise	Duration (Number of Repetitions)
4	Grasping** In the standing position, feet at shoulder width with free breathing: A--arms straight forward, hold them there, compress the hand rapidly into a fist, then release;	8-16 times
	B--same but with arms upward; C--same but with arms to the side; D--same, arms downward	4 times
5	Circular movement of fists* With feet at shoulder width, arms straight out to the sides, hand in fists, make four rotations of the fists forward, then four rotations back. Free breathing	4 times
6	Circular motions with arms straight* With feet at shoulder width, arms downward, tight fists: A--move both arms togethor forward, upward, backward then downward;	4 times
	B--same in opposite direction. Free breathing	4 times
7	Head tilt With feet at shoulder width, arms at the waist: A--tilt head forward and backward;	8-16 times
	B--tilt head left and right. Free breathing	8-16 times
8	Head turns Same position, turn head fully left and right. Free breathing	8-16 times
9	Circular motion of head In the same position: A--tilt head forward, move it to the left, to the rear, to the right, forward;	4 times
	B--same, to the right. Free breathing	2-4 times

Number	Name and Brief Description of Exercise	Duration (Number of Repetitions)
10	Body tilts* From same position with legs straight: A--tilt body forward rapidly, touch floor with hands (exhale), then raise hands upward, rise up on toes, jump (inhale); B--with left hand behind back, right hand upward, tilt twice to the left (exhale), change position of hands (inhale)--tilt twice to the right (exhale)	4 times 4 times
11	Body turns* With hands at side, feet at shoulder width, without raising feet from floor, turn body as far as possible left--right: A--with vertical position of body; B--with body tilted forward. Free breathing	 8-16 times 8-16 times
12	Circular body motions From the standing position, feet at shoulder width, hands on waist: A--tilt body forward without raising feet from floor, move it to the left, to the back, to the right, forward; B--same, opposite direction. Free breathing	 4 times 2-4 times
13	Deep knee bends A--standing position, heels together, toes together, hands at waist, bend knees, without separating knees or lifting heels from floor (exhale)--stand to initial position (inhale); B--with hands on waist, drop down, left knee forward then spring upward and drop down three times, then change position, right knee forward and spring upward again three times. Free breathing	8-16 times 2-4 times
14	Kicks A--standing position, legs together, arms at the side--move arms forward and at the same time kick the left leg up (exhale) until it touches the arms, then return to initial position (inhale). Do the same thing with the right leg;	4-8 times

Number	Name and Brief Description of Exercise	Duration (Number of Repetitions)
	B--from same position, kick left leg to to left, return, then right leg to the right, return.	4 times
	Free breathing;	
	C--from same position, kick left leg to the rear, return, then right leg, return.	4 times
	Free breathing;	
	D--from standing position, feet apart, arms extended to the right--kick left leg, arms to the left (exhale), return leg, arms to the right, then left (inhale); do the same thing with the right leg.	4 times
15	Running or jumping in place, including jumps with crossing of legs, jumps on one leg, jumps with rotation in the air by 90, 180 and 360°, etc.	1-2 min.
	Free breathing	

The morning exercises should be completed with water procedures--dousing or rubbing with a towel wet with water at room temperature, then with colder water.

At the Airfield

The airfield refers to an area specially equipped to allow takeoff, landing, parking and servicing of aircraft. Parachute jumps are also generally performed at airfields.

Before walking around an airfield, take a look around. Otherwise, you may be struck by a moving airplane or a descending parachutist.

If you see an aircraft parked with its engines operating, walk around it to the rear (unless it is a jet plane), in which case walk around it to the front, but at least 10 m away from the air intake; also walk around the front of helicopters. If you hear that the engine of the aircraft is increasing its speed, move away to one side--the airplane may be beginning to taxi.

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*Exercise may be performed with weights.

**Exercise can be done with grip springs, cutting number of repetitions in half.

Near areas set aside for aircraft it is necessary to be particularly careful, and you should not be on taxiways or runways at all.

A parachutist who accidently lands on a runway or taxiway should collect his parachute and immediately leave the runway or taxiway (move off to one side).

Groups of people may move around airfields only in formation.

It is permissible to cross runways (on motor vehicles) only with the permission of the flight leader.

When it is necessary to walk or drive to the other side of an airfield, move around outside the runways, or better yet--around the edge of the airfield. Particular care must be exercised in the descent zone--near the beginning or end of the runway--where aircraft descending or taking off pass low over the ground.

It is not difficult to recognize runways and taxiways. At large, well-equipped airfields, they are usually paved (concrete). In winter, they are cleared of snow.

Both at major (concrete paved) and at grassy (sod) airfields or landing areas, starting areas are marked. Along the runway to the left and right of the starting area there will be a single row of markers, easily seen from the ground or the air: in the summer these markers are white; in the winter, they are red or black.

Beside the touchdown point of aircraft, to the left of the landing strip, the landing T mark will be made using cloth strips of the same color as the starting position markers. Limiters may be placed before and behind the "T" using the same type of marker (aircraft making landings should touch down somewhere between these limiters). The same type of cloth strips are used to lay out the "+" (cross) sign--the precise landing point for parachutists.

The taxiways, aircraft parking areas and equipment parking areas at the starting position, areas for people ("square") will be marked with flags and indicators (tablets).

At night, runways are marked with white flares. At the beginning and the end of the runway, red flares mark its corners. The point of touchdown of the aircraft is marked with a line of green flares. Blue lights mark the taxiways.

One should be careful and attentive to the situation in the air and on the ground even if flights or parachute jumps are not planned--the arifield may be used for a sudden forced landing by an aircraft flying nearby.

Everyone at the starting position must stay in the area set aside for people--in the "square." You should leave this area only with your instructor's permission.

It is dangerous to remain outside the "square," particularly to sit or lie in high grass at the airfield: the driver of a vehicle servicing flights may not notice someone in the grass and might run over him.

One should also be observant even in the "square," although it is the safest place at the airfield. No aircraft or vehicle will taxi or drive through the square, but an inexperienced parachutist might land in the square. In this case, the first one who notices that a parachutist is descending toward the people must give the command: "Careful--air!" so that the people can get out of the way.

Smoking is permitted at an airfield only in a specially designated area (generally in the "square"). It is categorically forbidden to smoke or use an open flame near aircraft, parachutes or technical equipment.

After studying the rules for moving around the airfield and observing them, we can familiarize ourselves with the aircraft.

All aircraft are reaction vehicles to some extent. Except when they are gliding or slowing down, every aircraft moves forward due to the reaction force created by pushing air or some other gas with mass backward.

Sometimes using a propeller rotated by a piston-type internal combustion engine, atmospheric air is forced to the rear. Aircraft of this type are called propeller or piston aircraft. They are comparatively slow.

In other cases, the gasses formed in a combustion chamber in a reaction engine are thrown to the rear. These aircraft are called jet aircraft. The speeds of jet aircraft may be several times greater than the speed of sound.

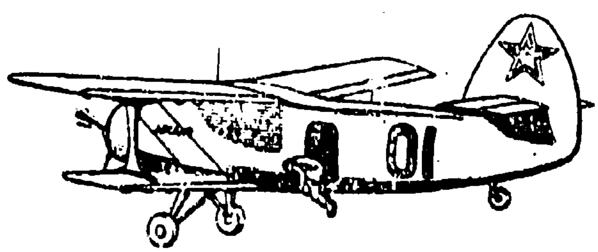

Figure 38. The An-2 Aircraft

There are also "hybrid" aircraft--turboprops. In these aircraft, the thrust is created both by the flow of the exhaust gasses from the reaction tube of the engine and due to the movement of air by a propeller. Turboprop aircraft are medium-speed aircraft. They are used as both passenger and transport-landing aircraft.

Beginning parachutists generally perform their first jumps from the An-2 piston aircraft (Figure 38). This is a small transport aircraft with two wings (upper and lower)--a biplane. The wings give it sufficient lift at speeds slightly over 100 km/hr (the speed of a modern automobile). At the end of the fusilage is the tail: the rudder and stabilizer elements

The rudder and stabilizer make the aircraft stable in both course and altitude. The control surfaces of the tail change the position of the longitudinal axis of the aircraft in space and, consequently, the direction of its motion. In addition to these surfaces, there are aelarons on the rear portion of the wings, controlling the bank of the aircraft.

The control surfaces are moved through a system of levers and lines from the pilots cabin.

These control surfaces, the vital control organs of the aircraft, must not be touched unless absolutely necessary.

The propeller group is located at the front of the fusilage.

The An-2 landing gear do not retract, and consist of two main wheels (beneath the lower wing) and one tail wheel. Special skis may replace the wheels of this aircraft for the winter.

The fusilage of the An-2 aircraft consists of three sections: the front section or pilots cabin, the mid section or passenger's cabin and the tail section or baggage compartment. The sections are divided by bulkheads with doors.

On the left rear portion of the passenger's cabin is the entrance door. Parachutists leave the aircraft through this door.

Parachute jumps are generally not performed from jet aircraft. Only experimental or test jumps and forced jumps are made from jets. For this purpose they are equipped with catapult devices and automatic devices. Modern catapult devices allow the pilot to evacuate the aircraft at any altitude.

Rescue parachutes are used on all types of aircraft. The only exceptions are passenger aircraft and helicopters.

Psychological and Ground Training of the Parachutist

Everyone has an instinctive fear of heights. This feeling is closely related to the instinct for self-preservation and helps to protect us as we travel through life. But when a man begins to fall through the air, this feeling can be quite unpleasant for him.

This feeling of fear can make a man with weak nerves and heart numb just when rapid, correct and precise actions are required, forcing him to make unconscious and unexpected decisions, frequently resulting only in harm, hindering the normal course of the process, depriving him of his memory when it is most needed.

Therefore, before he goes into the air, anyone planning to make a parachute jump should learn how to overcome this harmful instinct with his will and intelligence while still on the ground.

First of all, one should understand that fear of heights is a normal phenomena. Only young children or the mentally ill fail to have the normal defense reflexes when exposed to heights. However, a parachutist need not be afraid of heights: he has his parachute. With a parachute, he should be afraid not of height, but of insufficient height. If there is enough height, his parachute will open. The parachutist must firmly believe in the reliability of his parachute. In order to be sure of its reliability, he must study the design of the parachute, the interaction of the parts upon opening and must know the strengths of the individual parts. He must then learn how to fold it, pack it and use it well.

As a result, he should be well aware that his parachute is strong enough, that when it is properly prepared and when all jumping rules are observed, it will always open.

To avoid errors during jumps, parachutists are trained in advance on the ground, learning all actions which he must perform until they become automatic: from taking his place in the aircraft to completion of his landing[1].

All elements of a jump must be worked out on the ground until the parachutist will be able to act properly without confusion the air, even if fear paralizes his consciousness (i.e., he must be able to act properly and capably, even if subconsciously).

If a man with normal psychological strengths develops the additional qualities needed by a parachutist; fear will no longer be a brake, but rather an accelerator for the process of thinking. In a difficult situation, his consciousness will work rapidly, and the feeling of fear itself will be a sports incentive for him.

What actions must the parachutist learn using his trainers on the ground?

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[1] A landing cannot be considered complete until the canopy of the parachute has been collapsed.

First of all, he must learn to take his place in the aircraft properly, then prepare for his jump and leave the aircraft.

This is very important because order must always be maintained on board the aircraft. The parachutist must not walk around the cabin without the permission of the instructor, and in preparing to jump he should not move around near the door, since this changes the centering of the aircraft, making piloting more difficult.

All actions of future parachutists are practiced using models of aircraft cabins, made in actual size. First the actions are practiced without parachutes, then with training parachutes. The extraction line and rip cord for training parachutes are mounted freely, so that the pack does not actually open, which would dump out the canopy, since otherwise repetition of exercises would be made difficult.

Let us study the training of a parachutist for jumps from an An-2 aircraft.

A group of parachutists (ten men) enters the aircraft. The man who will jump last enters first and takes his seat on the right front seat, the man who will jump next to last enters next and sits beside the first man, etc. The first six men sit on the right side, the seventh (who will jump fourth) sits on the left front seat, the eights sits beside him, etc. The man who will jump first enters the aircraft last and sits by the door. All sit turned halfway toward the tail of the aircraft.

After this, the instructor fastens the snaplock of the extraction line of each man on the static line, takes up the slack in the line and inserts it beneath the pack rubber band of the upper flap.

After imitating the climb to altitude, on the signal "Get ready!" the instructor opens the door, and the parachutists who are to jump on the first pass stand up and occupy the initial position: the right hand clasps the rip cord ring of the main parachute, the left hand is used to pull the reserve parachute in tight.

On the command "Go!" the parachutists leave the cabin one after another at intervals of 2 seconds, with the body tilted slightly forward. They do this by standing with the left leg in the lower rear corner of the door, then stepping overboard with the right leg. One to two seconds after stepping out, the parachutist should pull the rip cord of his main parachute.

This exercise is repeated until each man can perform all the necessary actions easily and precisely.

The men then begin practicing what the parachutist must do in the air after his parachute opens. These drills are performed using suspension systems hanging from supporting bars.

After imitating the opening of the parachute, the beginning parachutist looks upward and inspects his canopy; is it fully open, has it torn (should the reserve parachute be opened). He then looks around to be sure he is not swinging toward other parachutists. If there is a danger of this, he pulls on the straps (1 m) in the direction toward which he should move to avoid a collision.

He then secures his rip cord ring to avoid losing it and settles himself more comfortably in the suspension system. The parachutist does this as follows: he grasps the right group of straps in his right hand (free ends) and, pulling on them, uses the thumb of his left hand to move the main strap of the suspension system forward down his thigh. He then changes the position of his hands and performs a similar operation on the other side. Seated comfortably, he looks around once more and determines the direction of his movement; before landing, he must turn to face the direction of his movement (downwind). Of course, in a trainer the parachutist does not actually move and some sort of panel must be moved beneath him to represent the movement of the surface of the earth.

The parachutist turns in the direction of his drift by crossing the straps of the free ends of the suspension system. To turn to the right, the parachutist moves his right hand along the straps to the right and grasps the left rear strap on the outside with his palm forward. At the same time he moves his left hand--also on the outside and also palm forward--to grasp the right front strap.

When these straps are pulled to the side and downward, the parachutist will turn in his straps. The rate of turning depends on the amount of tension applied. To turn to the left, the position of the hands is changed: the parachutist grabs the right rear strap with his left hand, the left front strap with his right hand[1].

Along with turning, the parachutist learns to prepare himself for landing properly--to hold his legs together, slightly bent at the knees, feet at the same level and parallel to the surface.

The parachutist practices his landing techniques as follows.

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[1]In a real jump, the beginning parachutist should perform this action several times long before landing in order to test himself: to be sure he remembers how it is done, so that he will not be confused as he approaches the ground.

He first practices jumping in place while landing with his feet flat, together and knees slightly bent. He then jumps from a trampoline, landing as in a parachute jump (with the feet flat, together and slightly bent at the knees with the arms upward, as if holding the straps). The first jumps are made from a low trampoline, from a height of 1 m, then from a somewhat higher level (1.5 m) and, finally, from a high level (2 m).

The landing speed when jumps are made from the top step is approximately equal to the landing speed in an actual parachute jump. The parachutist works out his landing technique finally using a Bannikov trainer (suspension system mounted on a rocking arm with blocks and a winch).

This is done as follows. The parachutist rocks in the suspension system and during a forward swing, during its first half, the brake on the winch is released. The parachutist is thus swung forward and down to the ground, producing a motion imitating the motion involved in an actual landing.

Using this same type of trainer, combined with a moving model of an aircraft cabin, the parachutist practices his actions for the event of a total failure (failure of the pack to open) of the main parachute: if the parachute does not feel shaking (imitation of opening shock, created by the instructor by briefly releasing the winch brake) within three seconds after pulling the rip cord and is not turned legs downward, he immediately spreads his legs until his feet are further apart than his shoulders, pushes them forward and at the same time moves his left arm to the side. In an actual free fall, these actions will shift the parachutist to the position most favorable for opening of the reserve parachute--back toward the ground, tilted toward the right shoulder. Next, he pulls the rip cord of the reserve parachute with his right hand.

The technique of opening the reserve parachute in case of a partial failure of the main parachute is practiced on all trainers which carry a suspension system. This is done as follows. If within three seconds after pulling the rip cord the parachutist looking upward discovers a failure of the canopy (failures are imitated by the instructor by telling the parachutist: "Twisted lines," "Tear," or "Cover stuck"), he evaluates the situation: is he turning about his vertical axis with the parachute, and if so in what direction. After this, without losing time, he opens the reserve parachute: pressing it against himself with his left hand, he pulls the reserve shute rip cord with his right hand; then he pushes his right hand, palm away, between the canopy and the bottom of the pack and, using both hands, throws the canopy upward and away from himself in the direction of rotation. On the D-5, D-1-8, D-3 and PD-47 parachutes, the rotation will be very slow if present at all. If there is no rotation, he throws the canopy forward, upward and to the left, at the same time pulling the lines out of the loops and shaking them, causing the edge of canopy to spread more rapidly to open the reserve parachute.

In addition to these trainers, parachutists also use the Pronichev trainer. On this trainer they learn to overcome their fear of height and practice all actions beginning with separation from the aircraft and ending with landing. The actions are worked out in the sequence in which they will be performed in the air in an actual jump.

Jumps from parachute towers are performed for the same purposes as drills on the Pronichev trainer.

After practicing their actions on all trainers and passing their tests (with a grade of no less than "good"), the parachutists pack their parachutes (under the control of their instructor!), go through their medical examination and are ready for jumps.