ARMORED MEDICAL RESEARCH LABORATORY

FORT KNOX, KENTUCKY

Report On

PROJECT NO. T-1 - TEST OF SUSPENDERS, PACK, FIELD, CARGO AND COMBAT (SUPPORT OF THE PACK, FIELD, M-1944, BY MEANS OF SUSPENDERS WHICH INCORPORATE A STRAP TRAVERSING THE CHEST).

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Action copies have been forwarded to Office of the Surgeon General, Occupational Hygiene Branch for approval and execution.

Project No. T-1

11 April 1945

ARMORED MEDICAL RESEARCH LABORATORY
Fort Knox, Kentucky

Project No. T-1
SPMEA 727

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1. PROJECT: No. T-1 - Test of Suspenders, Pack, Field, Cargo and Combat, (Support of the Pack, Field, M-1944, by means of suspenders which incorporate a strap traversing the chest).

a. Authority: 1st Indorsement SPMDO-ASF-SGO, Washington, D. C., 17 October 1944.

b. Purpose: (1) To determine whether respiration is impaired by pack suspender straps which cross the chest, and (2) to design a simplified suspender for Pack, Field, Combat and Cargo, M-1944, incorporating this feature.

2. DISCUSSION:

a. In AMRL Project No. 42, Test of Pack, Field, Cargo; Pack, Field, Combat; and Suspenders, Pack, Field, Cargo and Combat, 29 August 1944, it was suggested that the ease of carrying this pack might be increased if the suspenders included a strap which crossed the chest. In accordance with this suggestion, a model was fabricated by the Quartermaster as Suspender, Type 4. Preliminary observations on it indicated that chest-crossing suspenders would probably be acceptable, but the general design of the model submitted was not an optimal one.

b. Efforts were then directed toward identification of the desirable characteristics of pack suspenders, and a suspender of simplified design was evolved. Both field and laboratory tests have been conducted to evaluate its advantages from both the utilitarian and medical points of view.

3. CONCLUSIONS:

a. A Modified Suspender for the Pack, Field, Cargo, and Combat, M-1944 has been designed. Its novel characteristics are: (1) inclusion of a strap crossing the chest; (2) provision of a means for rapid removal of the pack; (3) simplicity of both general design and of adjustment for size; and (4) independent suspension of the cartridge belt.

b. Both field and laboratory tests have demonstrated that the chest strap improves the carry of the pack, does not interfere with respiration, and aids in the elimination of axillary compression by the suspenders.

c. Certain suggestions are made for the modification of the cartridge belt and attachment of the canteen to it.

4. RECOMMENDATIONS:

That the Modified Suspender described in Appendix I be manufactured in sufficient numbers, and be subjected to field tests by interested agencies.

Submitted by:

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7 Incls.

#1 - Appendix 1
#2 - Appendix II
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APPENDIX I

DISCUSSION OF CURRENT AND MODIFIED PACK SUSPENSIONS

1. Appraisal of Existing Pack Suspensions.

a. Functionally all pack suspenders in use by U. S. troops are alike in that they ultimately depend on compression of the anterior shoulder for support of the load to be carried. This is due to the fact that the same shoulder strap balances both the weight of the pack and the backward rotational tendency (torque). Whether the suspenders are sewn to the pack, and only support the cartridge belt incidentally, as in the case of the Pack, Field, M-1928 (Haversack), and the Pack, Field, M-1943 (Jungle Pack), or whether the cartridge belt is attached front and rear to the harness, and the pack then suspended from this unit, as in the case of the Pack, Field, M-1936 (Musette Bag), and the Pack, Field, M-1944 (Cargo and Combat), the result is the same. In all four of these packs pressure is exerted against the anterior shoulder as shown in Figure 1, a and b, and more particularly, against the axilla and lateral part of the front of the shoulder, with compression of the vital structures in these regions. Since the straps in each case come over the shoulder as over a pulley, it is impossible for any of these packs ever to be placed higher than the shoulder level, except when they are lashed to the body with excessive tightness.

b. The Pack, Field, M-1936, and the Pack, Field, M-1944 utilize attachment to the cartridge belt for the double purpose of supporting the belt and providing a balancing weight for the pack. Were the belt sufficiently heavy, it might conceivably operate as an effective counterweight. However, the cartridge belt, when loaded with 100 rounds of cal. 30 ammunition and a full canteen, weighs slightly less than 10 lbs. Since packs are always heavier than this, but little balancing effect can result, even granting that some staying power for the pack is derived from friction of the straps against the clothing. The net effect of this suspension is that the pack adjusts its position until its shift downward is checked by the pressure of the underarm and shoulder straps against the axilla and anterior shoulder, while at the same time, the front of the cartridge belt, especially when unloaded, tends to become displaced upward against the lower ribs.

c. The Packboard, on the other hand, utilizes a different principle for the suspension of its weight, as illustrated in Figure 1, c. Its weight is borne almost equally by the front and rear straps, the rigid structure compensating for the unequal length of the two straps. Its support comes from its lower end, and is borne by the top of the shoulders, for the most part. Thus it tends to slip downward scarcely at all. However, since the Packboard is supported from its lowest point there is a tendency for backward rotation of the load, the magnitude of this tendency being a function of the height of the Packboard, its weight, the degree of rearward projection of the load, and the angle of initial rearward tilt. In other words, the higher and the more posterior the center of gravity of the Packboard plus load, the greater the torque. This rotational

tendency is countered by making the Packboard of sufficient length so that its lower portion rests against the buttocks, thus preventing the top of the board from swinging away from the shoulders. In addition, because of its length and breadth, the attachment of the front strap to the lower outer corner of the Packboard serves to direct that segment of the strap which is in the region of the upper anterior chest a bit medial to the axilla, avoiding compression of the subjacent nerves and blood vessels.

d. It is generally believed that for greatest comfort, a pack should rest high on the shoulders. The reason customarily assigned is that the weight is thereby partially borne by the spinal column if the body is inclined at a slightly forward angle. But the Packboard, although comfortably carried when the wearer is standing erect, does not then rest on the upper spine. This explanation cannot therefore be regarded as essential to satisfactory pack support. A more likely explanation of the advantage of a high shoulder position is that the pack, when high, may be pulled forward against the anterior slope of the upper back, moving the center of gravity forward, with corresponding reduction of torque.

e. In summary, the disadvantage of all pack suspenders is that they ultimately depend for the support of the pack on compression of the anterior shoulder and of the axilla. This is productive of pain in the region of the clavicle, with reddening, corrugation, and even abrasion of the skin in this area; of pain and circulatory obstruction in the anterior axilla, due to compression of the poorly protected nerves and blood vessels there (Fig. 2); and of generalized aching and fatigue (Appendix III). By contrast, the Packboard produces these effects to a lesser degree because the weight is borne at the crest of the shoulders; the straps are directed slightly medial to the axilla; and the backward rotational tendency of the load is overcome by the apposition of the lower part of the board against the buttocks.

2. Requirements of an Improved Design.

a. From consideration of the present suspender deficiencies, and of the advantageous features of the Packboard suspension, the characteristics of an improved pack harness can be defined. The desirable features of the Packboard harness could be incorporated in any pack were that pack long enough, broad enough and sufficiently rigid, but a pack of such size is not deemed suitable for most combat troops.

b. In general, pack suspenders should:

(1) Avoid compression of the axillary structures;

(2) Control the tendency for the pack to slip downward;

(3) Balance the backward rotational tendency of the pack, and avoid excessive rearward pull on the shoulders;

(4) Distribute the strap pressure evenly on the shoulders;

(5) Minimize lateral and vertical swing of the pack during running;

(6) Not depend on attachment of the pack harness to the cartridge belt;

(7) Afford a release for ready removal of the pack in case of emergency;

(8) Avoid location of hardware and heavy seams where straps press against the body.

c. In accordance with these general principles, the existing pack suspenders have been modified. The Modified Suspender has been subjected to both field and laboratory tests, the results of which are given in Appendices II and III. The tests were conducted in conjunction with Pack, Field, Combat and with the Pack, Field, Combat and Cargo, but the principles involved are applicable to any pack of future design.

3. Characteristics of the Modified Suspender.

a. The Modified Suspender (Photo 1) is in the shape of an "H", the upper arms of which are padded and attached to the top of the pack, while the lower arms are attached to the bottom. The cross piece represents the chest strap, located at a comfortable position on the chest by adjustment of the buckles on the upper strap segments. The chest strap attaches to the vertical portion of the suspender by means of rings, to allow automatic universal fit. Its length is adjustable, and it includes a snap hook for prompt removal of the pack in case of emergency. A more easily operated release feature would be preferred if such is available. There is no connection between the suspenders and the cartridge belt, since such has been demonstrated to be unnecessary.

b. The suspender straps are intended to be kept somewhat loose when the pack is first put on so that tightening the strap across the chest will keep the direction of the suspenders vertical and cause them to descend over the thickness of the chest muscles medial to the axillae (Fig. 2). Thus, also, the chest strap is straight rather than curved around the chest contour, and pressure of the strap against the anterior chest is minimized.

c. This suspender relies on anterior shoulder pressure for support of the pack, to some extent similar to previous pack suspenders, with the difference, however, that the pressure is better distributed and is exerted only on structures well able to tolerate it (Appendix II).

4. Specific Questions Submitted by OQMG.

a. Interference with respiration - See Appendices II and III.

b. Accessibility of pockets, etc. - The breast pockets are covered by the chest strap. They become accessible by releasing this strap.

c. Cutting action of suspenders - This is avoided. See Photo 2 and Figure 2.

d. Opening of jacket for ventilation - This can be accomplished without releasing the chest strap if desired. The chest strap is narrow and covers little of the body surface.

APPENDIX II

PHYSIOLOGIC STUDIES

1. Treadmill Observations.

a. Pack suspenders have heretofore not included straps which cross the chest, probably because it has been presumed that respiratory function would be impaired. Therefore, controlled laboratory studies were conducted to evaluate this point.

b. Four (4) subjects were marched on the treadmill carrying the pack, weighing 25 lbs., supported by means of both the Modified Suspender and the Suspender, Pack, Field, Cargo and Combat. The treadmill, elevated to a 3% grade, was operated at 2.75 mph. It was enclosed in a wind tunnel in one of the constant temperature rooms of the laboratory, wherein the environmental conditions were maintained at a dry bulb temperature of 69-72°F, a wet bulb temperature of 57-60°F (RH approx. 50%), and a wind velocity of 30-40 ft./min. A cool environment was deliberately chosen in order to avoid acclimatization effects. The subjects' clothing consisted of two-piece fatigues, summer underwear, and service shoes.

c. For each test a 45-minute walk was used. Beginning at 37 min., the subjects' expired air was directed into a spirometer, the 5 minutes at the end of the walk, after the spirometer was rinsed, being used for collecting the specimen. During this 5-minute period respirations were accurately counted, so that tidal air volume might be computed. The stirred expired air was sampled and analyzed in the Haldane apparatus. Pulse was counted toward the end of the walk, and rectal temperatures were taken. These data are shown in Table 1.

TABLE 1

PHYSIOLOGIC DATA ON PACK CARRYING
AT END OF 45-MINUTE WALK ON TREADMILL IN COOL ENVIRONMENT

Subject		Tidal Air Volume (L)*	Resp Rate Per Min.*	Min. Volume (L)/Min.*	Metabolic Rate Cals/M^2/Hr	Final Rectal Temp. (^oF)	Final Pulse Rate
Ne							
Ht. 169 cm.	:a:	1.28	21.4	27.3	195	100.4	112
Wt. 64 kg.	:b:	1.33	20.0	26.5	190	99.7	110
Surface Area 1.74 M^2	:c:	-	-	-	-	99.7	108
Age 36	:d:	1.57	14.8	23.3	168	99.8	106
Ci							
Ht. 167 cm.	:a:	-	-	-	-	99.9	116
Wt. 68 kg.	:b:	1.08	27.8	29.9	188	99.8	118
Surface Area 1.78 M^2	:c:	0.99	29.8	29.4	184	100.0	116
Age 27	:d:	0.95	27.8	26.4	172	100.0	102
Su							
Ht. 182 cm.	:a:	0.78	44.2	34.3	188	100.7	108
Wt. 73 kg.	:b:	0.84	43.0	36.1	191	100.8	110
Surface Area 1.93 M^2	:c:	0.86	39.2	33.7	181	100.4	126
Age 18	:d:	-	-	-	-	-	-
Wr							
Ht. 171 cm.	:a:	0.87	45.2	39.3	197	99.5	114
Wt. 63 kg.	:b:	0.83	44.2	36.5	197	99.8	116
Surface Area 1.75 M^2	:c:	0.81	47.0	38.1	197	100.2	116
Age 19	:d:	0.88	52.2	46.2	184	100.0	102

* Arithmetic Mean for 5-minute Period

:a: Carrying Pack, Field, Combat and Cargo, M-1944, Suspender, Type 7, weighing 25 lbs., and loaded cartridge belt, weighing 6½ lbs.
:b: Same with Modified Suspender and chest strap.
:c: " " " " " " "
:d: Walking without pack or cartridge belt.

d. Very little difference appears to exist with regard to any of the physiological indices, between the Suspender, Pack, Field, Cargo and Combat, Type 7, and the Modified Suspender with chest strap. It is of interest that carrying the pack adds surprisingly little to the work expenditure of walking on the treadmill under the conditions of this test. The consistently high respiratory rates and low tidal volumes of subjects Su and Wr are attributed to inexperience with the nose clamp and mouth piece of the apparatus for collecting expired air.

2. Vital Capacity.

Measurements of vital capacity were made on the subjects who participated in the field test described in Appendix III. Three sets of measurements were taken: while wearing no pack; while wearing the Pack, Field, Cargo and Combat, M-1944, supported by Suspenders, Type 7; and while wearing the same pack supported by the Modified Suspenders. These measurements are shown in Table 2 along with the heights and weights of the men. Here, also, it is apparent that although the wearing of either pack does reduce vital capacity slightly, the difference between the use of Suspender, Pack, Field, Combat and Cargo, Type 7, and of the Modified Suspender with chest strap is quite small.

TABLE 2

VITAL CAPACITIES OF SUBJECTS SUPPORTING PACK WITH DIFFERENT SUSPENDERS

Subject	Height (Inches)	Weight (Pounds)	VITAL CAPACITY (LITERS)		
			No Pack Control	Pack Field M-1944 with Suspender Type 7	Pack Field M-1944 with Modified Suspender
Wro	68	145	4.24	4.28	4.12
How	74	170	5.72	5.16	5.03
Fle	70	163	4.55	4.38	4.18
Paw	69	154	4.16	4.08	3.94
Pyo	65	138	4.27	3.82	3.94
Sca	68	135	4.24	3.69	3.90
She	69	150	3.77	3.41	3.82
Rot	73	200	5.01	5.07	4.90
Rob	69	174	4.39	4.20	3.96
For	68	153	4.45	4.26	3.63
Pet	68	144	3.68	3.39	3.47
Rod	63	130	3.66	3.37	3.43
MEAN			4.35	4.09	4.03

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3. Pressures Exerted by Suspenders.

The redistribution and relocation of pressure accomplished by the Modified Suspender is illustrated in Figure 2 and in Photo 2. Measurements of this pressure were made by pulling with a spring, normal to the point of contact of the suspender with the body, against a brass strip ½" in breadth which was placed under the suspenders to provide an even distribution of the force. The end point was that amount of pull at which the wearer first perceived reduction of the suspender pressure. For these measurements, the suspender supported a pack weighing 25 lbs. Results are given in Table 3.

TABLE 3

COMPARATIVE PRESSURES, AT AREAS INDICATED, OF (1) MODIFIED SUSPENDER, AND (2) SUSPENDER, PACK, FIELD, CARGO AND COMBAT, TYPE 7 WHEN SUPPORTING THE PACK, FIELD, CARGO AND COMBAT, M-1944, WEIGHING 25 LBS.

AREA	Suspender M-1944 Lb./sq. inch	Modified Suspender Lb./sq. inch
Top of shoulder	4	4¼
Immediately below clavicle	3½	2
Front of axilla	3¼	*
Body of pectoral muscle	*	3¼
Across front of chest	*	<1

* Indicates no strap in this location

a. These measurements indicate that with the Modified Suspender, the pressure is exerted on regions of the shoulder and chest wall which are well able to tolerate it, i.e., the crest of the shoulder and the body of the pectoral muscle.

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APPENDIX III

FIELD TEST OF MODIFIED SUSPENDERS

1. Introductory.

a. A field test was conducted to compare the Modified Suspenders with the Suspenders, Pack, Field, Combat and Cargo, Type 7 in order to obtain information on the subjective experiences of the men, particularly with regard to comfort and fatigue. Certain objective observations with regard to pulse rate, increase in hand volume, and amount of slippage of the pack were also recorded. Inasmuch as the weather conditions were highly favorable for road marching, the physiologic load imposed on the subjects was minimal; consequently, the pulse and hand volume data were not revealing. Comparisons of the magnitude of slipping of the pack did not provide significant information since the hardware initially provided for the Modified Pack slipped on the webbing. The subjective experiences of the subjects, however, were clear-cut.

b. Twelve selected men from the Tank Training Detachment at Fort Knox were employed as subjects. Since these men had had little infantry training in recent months, they were conditioned by two days' marching, one day with no load, and a second day with a light load. On the third day, the men were divided into two groups, A and B, of 6 subjects each, approximately equal in weight, height and physical condition. Each group was placed in charge of a non-commissioned officer and their unsolicited complaints and approvals were systematically noted. The order and conditions of the tests are given in Table 4, together with the environmental temperatures encountered.

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TABLE 4

ORDER OF TESTING

		Modified Suspender and Pack	Suspender Type 7 M-1944 Pack	Environmental Temperature	
				DB	WB
Day	3*AM	A	B	38.0	35.5
	PM	B	A	-	-
	4*AM	B	A	41.0	37.0
	PM	A	B	44.0	37.5
	5**AM	A	B	43.5	38.5
	PM	B	A	53.0	43.0
	6**AM	B	A	53.0	39.5
	PM	A	B	62.5	47.0
	7***AM	A	B	-	-
	PM	B	A	-	-

* On days 3 and 4, Combat Pack with Blanket Roll and Shelter half, Rifle and loaded cartridge belt were carried. The men marched 6½ miles in the morning and 4½ miles in the afternoon.

** On days 5 and 6, Combat and Cargo Packs with rifle and loaded cartridge belt, but without Roll were carried. The men march 6½ miles in the morning and 4½ miles in the afternoon.

*** Forced march with Combat and Cargo Pack, loaded cartridge belt, but without rifle. Course 1 mile at best speed.

Weight of Combat Pack with Roll - 18½ lbs.
Weight of Combat and Cargo Pack - 25 lbs.
Weight of loaded cartridge belt - 9 3/4 lbs.
Weight of rifle - - - - - - - - - 10½ lbs.

2. Subjective Reactions.

a. The attitude of the men during the tests was informative. Only one marching experience with the combat and cargo packs was necessary to demonstrate a sharp difference in morale between the two test groups. On the first day, the group carrying the pack with Modified Suspender was cheerful during the march, and showed no signs of dissatisfaction or lack of cooperation. Conversely, the group carrying the Pack, M-1944, with the Type 7 Suspender bitterly complained of such physical distress as aching shoulders, back and legs, and several of the group asserted they could not possibly finish the specified course which the first group completed without complaint. The test groups then exchanged packs, as indicated in Table 4, with the result that there occurred an immediate reversal of morale in the two test groups. After only one experience, both groups of men in contemplating the marching schedule looked forward with relief to carrying the Modified Pack while they were morose and disgruntled in anticipating the Pack M-1944 and Type 7 Suspender.

b. The men's reactions to the two packs were probably based upon a combination of sensations, of some of which they were acutely aware, and others less so. The subjects were not aware that the Modified Suspender had been developed at the Laboratory. Some of the complaints were sufficiently uniform throughout the test to form the basis for a questionnaire, the results of which leave no doubt as to the preference for the Modified Suspender (Table 5).

TABLE 5

RESULTS OF QUESTIONNAIRE PERTAINING TO SUBJECTIVE REACTIONS
(12 SUBJECTS)

	Modified Suspender	Suspender M-1944
1. Which of the two packs do you prefer: the one with the chest strap or without?	12	0
2. Which of the two straps seemed to permit the pack to slip down in the back more?	0	11
3. Which of the two packs seems to pull the body backward?	1	11

4.

Location of Muscular Aches and Discomfort	Suspender M-1944	Modified Suspender
Shoulders	12	1
Front of lower leg	10	0
Back of lower leg	10	0
Back	9	0
Back of thigh	8	0
Front of thigh	7	0
Ankle	7	0

	No	Yes
5. Does the strap crossing the chest interfere with breathing in any way?	12	0
6. Is it necessary to support the cartridge belt by means of harness straps?	12	0

3. Muscular Aching.

The frequency and widespread distribution of body aches and discomforts among the individuals carrying the pack supported by the Suspender, Type 7, was unexpected, and the explanation for its occurrence is not clear. The only reason which can be assigned at present, relates the entire phenomenon to the location of the forward shoulder straps of the Suspender, Type 7, near the lateral end of the clavicle where the upper arm joins the shoulder (Photo 2 and Fig. 2). These straps sensibly pull the shoulders backward to impose a posture very similar to that of "attention". It is believed that this pull is an intolerable one for prolonged periods especially when pressure is exerted to enforce it, and that reflexly the chest and shoulder muscles oppose it by contracting. In order to do so effectively, it is probable that the tone of the muscles holding the body erect must be increased. If this hypothetical explanation is the true one, it would not be unlikely that when the muscular effort of marching is added, generalized muscle pain may be produced.

4. Horizontal Chest Strap.

a. On the march none of the subjects was aware of any interference with breathing caused by the strap traversing the chest. The function of this strap is to connect the vertical suspender straps and pull them medially, thereby eliminating the axillary compression otherwise produced by the vertical straps. This results in greater comfort and the advantage was appreciated by the test subjects.

b. During the forced march of 1 mile, a few of the larger men found that the chest strap, as it was adjusted for routine marching felt tight for the double-time pace, and the accompanying thoracic movement of panting. Relief was readily obtained, however, by very slight loosening of the chest strap, but without loss of its effectiveness in its intended function.

5. Cartridge Belt Support.

a. The men were unanimous in disclaiming a need for support of the cartridge belt by harness straps. Pack harnesses in the past have been attached to the front and rear of cartridge belts to provide mutual counter-balancing of belt and pack. However, experience has shown that a downward shift of the pack on the back displaces the front of the cartridge belt a corresponding amount upward, leaving the belt in an unbalanced position, and producing discomfort by pressure against the lower ribs. This is believed to be the basis of the desire of some troops for a rear support for the cartridge belt.

b. On the forced march over a mile course most of the men covered approximately half the course at double time. Even after this trial with both types of packs, the men were practically unanimous in asserting that no attachment between suspender and belt is necessary. With or without the harness attachment, the belt bounces, and the pack does also. For creeping and crawling, the cartridge belt needs no support from above since it is naturally forced downward against the hips in this maneuver.

APPENDIX IV

MISCELLANEOUS FACTORS AFFECTING THE EASE WITH WHICH PACKS AND ACCESSORY EQUIPMENT MAY BE CARRIED

1. During the course of the field tests several observations were made of accessory imperfections, the correction of which would materially increase the infantryman's comfort on the march.

2. Canteen Attachment to the Cartridge Belt.

At present the canteen swings from the cartridge belt on a free, hinge-type buckle. In running, it bounces against the thigh and men usually use their hands to hold the canteen in place. It would appear that if the canteen were attached to the belt by means of a loop, it would remain in place during all types of activity. It is understood that this is under consideration at the present time.

3. Fit of Cartridge Belt, and Pressure of the Cargo Pack on the Belt.

The two rear ammunition pockets of the cartridge belt interfere with shortening the belt, so that small waisted men are unable to obtain a snug fit. In addition, the lower part of the Cargo Pack strikes against these pockets on all but the tallest men. Both of these sources of discomfort could be avoided by removing the two rear ammunition pockets on the belt and correspondingly increasing the capacity of the front pockets.

4. Shoulder Seams of Clothing.

The pack straps and the rifle strap, pressing on the shoulder, cause the clothing seams there to become impressed on the skin. It is suggested that diminishing the thickness of these seams would minimize this aggravation.

APPENDIX V

ADDITIONAL STUDIES ON DESIGN OF SUSPENDERS

In the course of development of the Modified Suspender, an alternate design was made and observed in field and laboratory tests, which, while utilizing the chest strap principle, was also intended to insure maintenance of the pack's location above shoulder level. To accomplish this, the support of the pack is obliged to be from the shoulder crest, with both the front and rear straps attached to the bottom of the pack, so that the tension on them is equalized. This type of support introduced the need for balancing the backward rotational tendency separately. The small amount of force needed could be supplied by means of a tumpline, but such would not be feasible because of interference with the slung rifle, helmet, etc. Accordingly, an attempt was made to balance the torque by means of an independent strap emanating from the top of the pack coming over the shoulder to attach low on the vertical suspender segment. This proved not only complex, since two straps thus crossed each shoulder, but also failed to accomplish its purpose for two reasons. First, since the Pack, Field, Combat and Cargo is not of sufficient length, the strap tensions were not equal, and the pack tended to slip down in back, causing the torque-balancing strap to tighten and bear part of the weight, thus negating its intended function. Secondly, the softness of the pack and its contents afforded insufficient rigidity for this type of support. This caused the pack to buckle and sag, and was additionally responsible for some of the slipping. The principle of this design is diagramed in Figure 3, wherein both the tumpline and the shoulder strap resisting backward torque are illustrated.

FIG. I

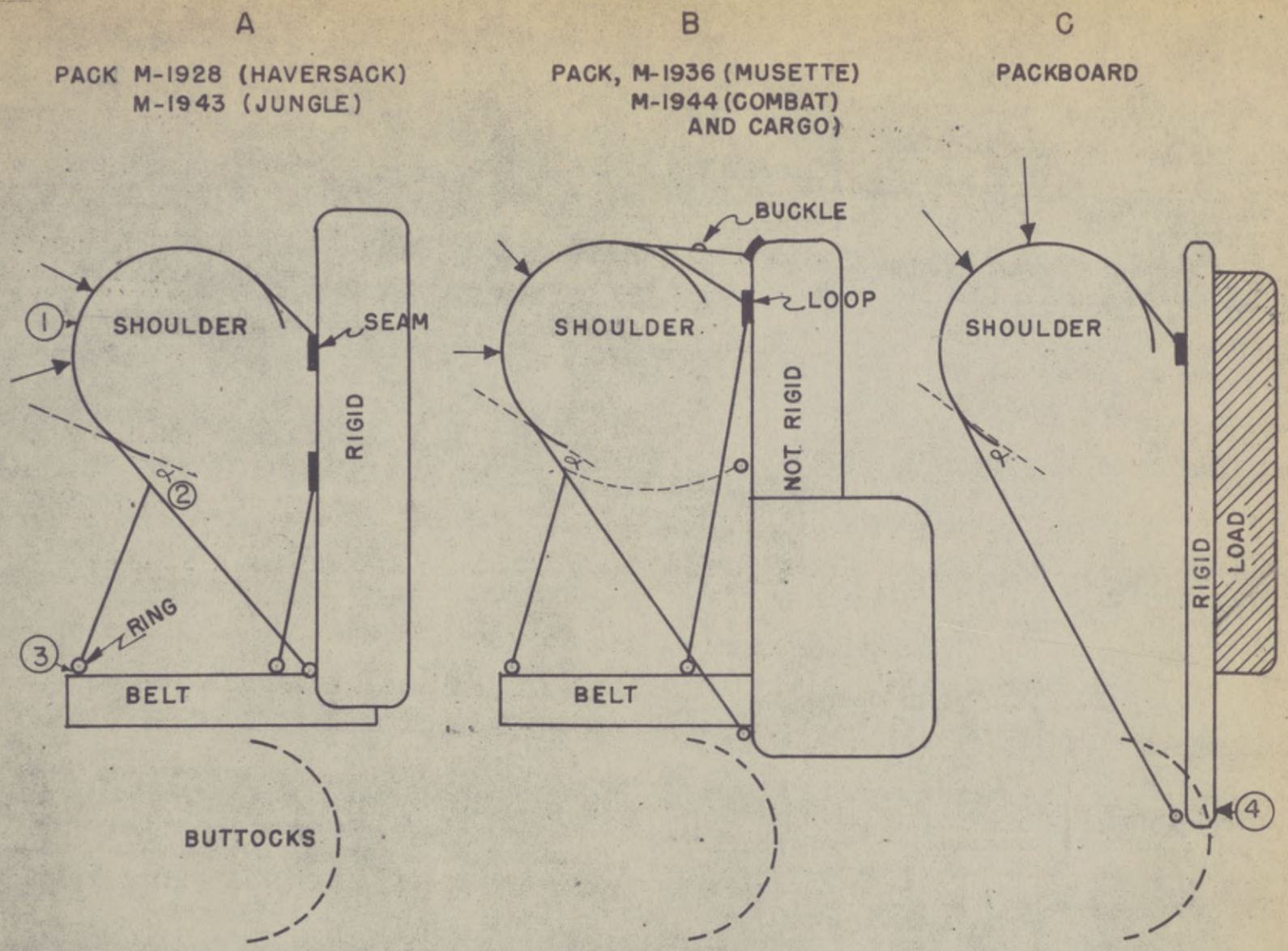

FIG. I

DIAGRAM OF PACK SUSPENSION OF VARIOUS PACKS

TO SHOW – WHEN PROPERLY FITTED.

1. LOCATION OF MAXIMUM SENSIBLE SHOULDER PRESSURE AT ARROWS.
2. ANGLE α OF STRAP TO TANGENT AT ARMPIT.
3. ATTACHMENT TO CARTRIDGE BELT.
4. POSITION OF LOWER PACKBOARD AGAINST BUTTOCKS.

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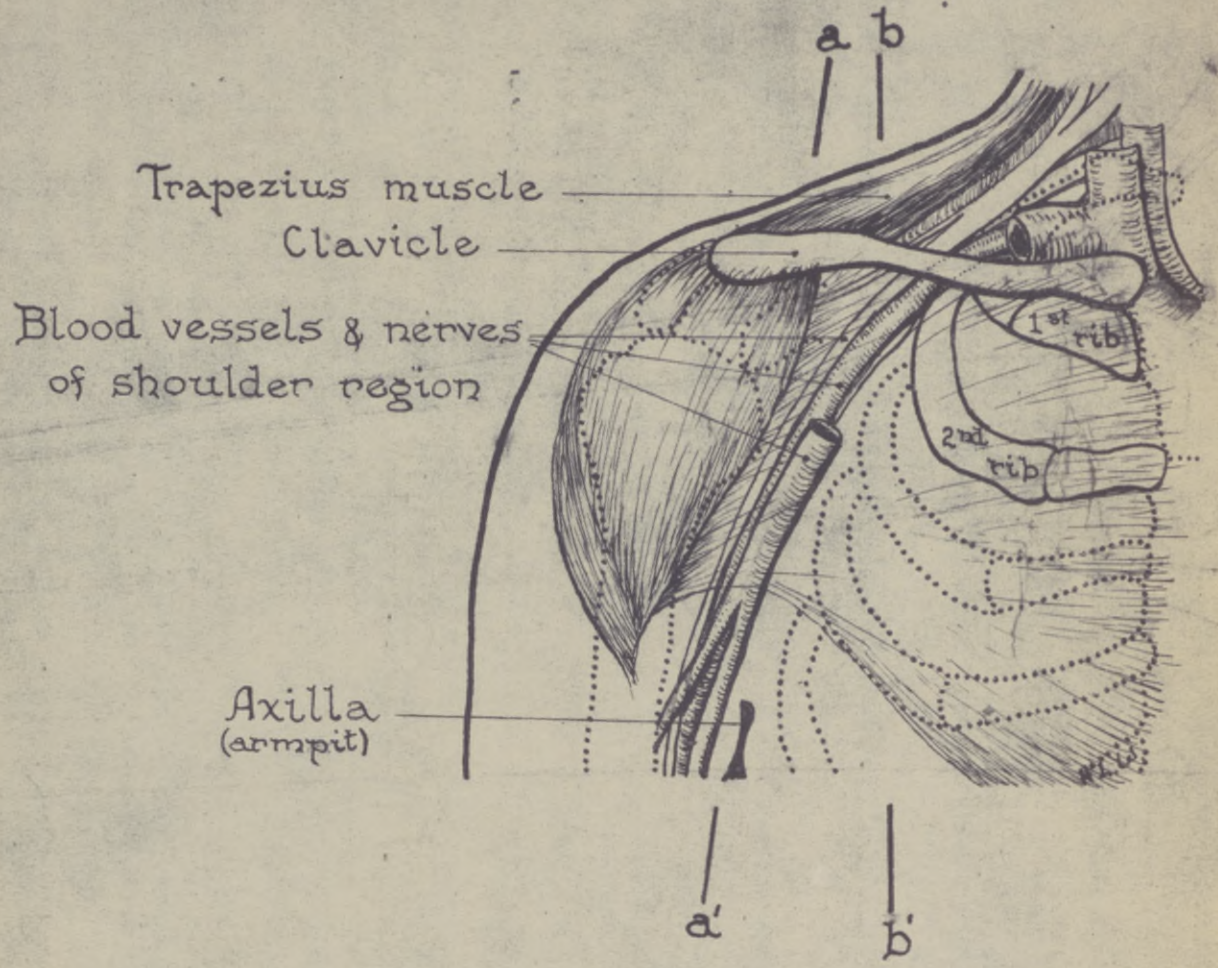
FIG. 2



ANATOMY OF ANTERIOR SHOULDER AND CHEST.

a - a' - DIRECTION OF SUSPENDER, PACK, FIELD M-1944, TYPE-7.

b - b' - DIRECTION OF MODIFIED SUSPENDER.

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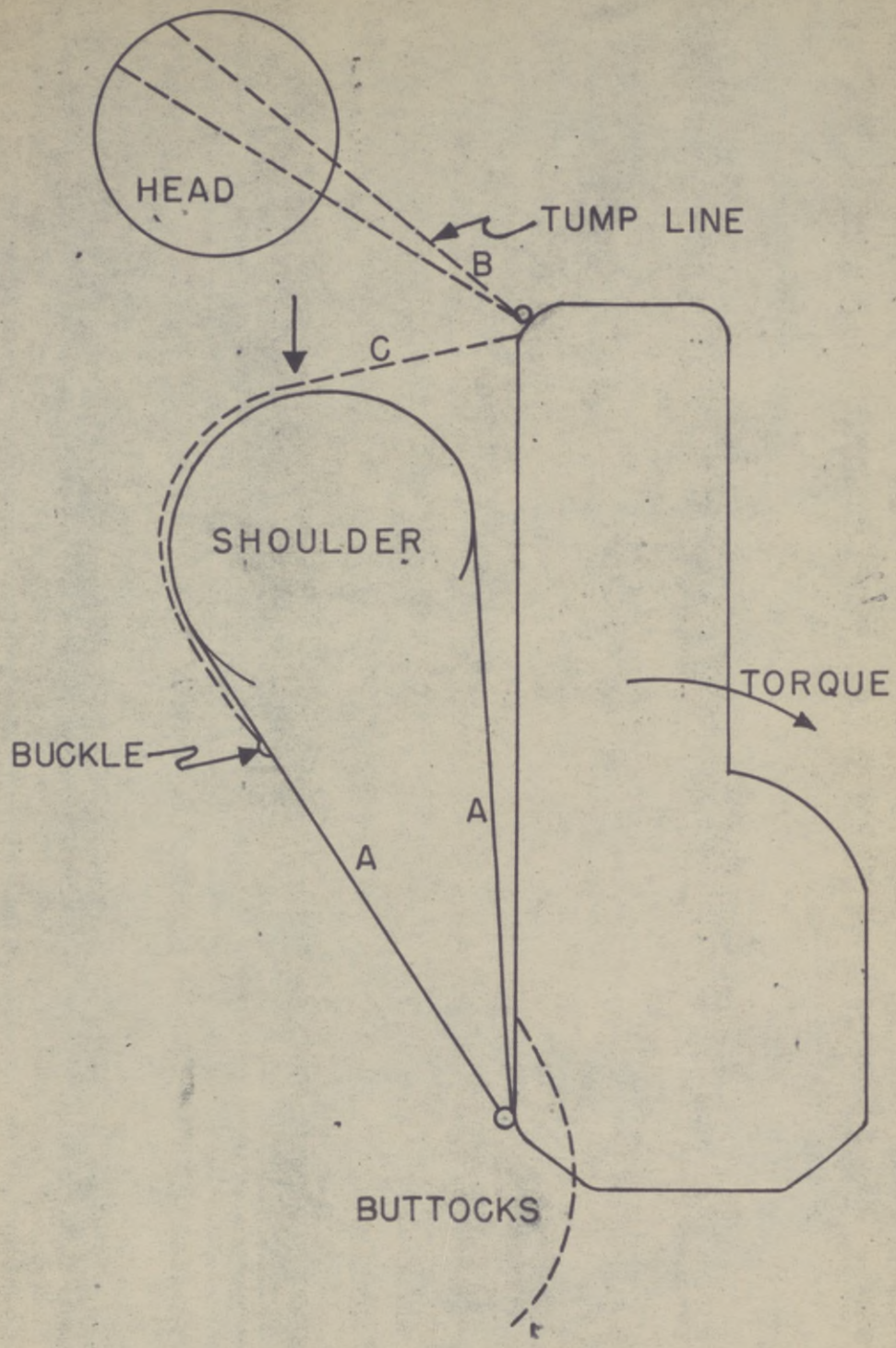
FIG. 2



SUPPORT OF PACK FROM CREST OF SHOULDER

a – EQUAL TENSION ON FRONT AND REAR STRAPS-A
b – BALANCE OF TORQUE BY TUMP LINE-B, OR ALTERNATELY
c – BALANCE OF TORQUE BY AUXILLIARY SHOULDER STRAP-C

FIG. 3

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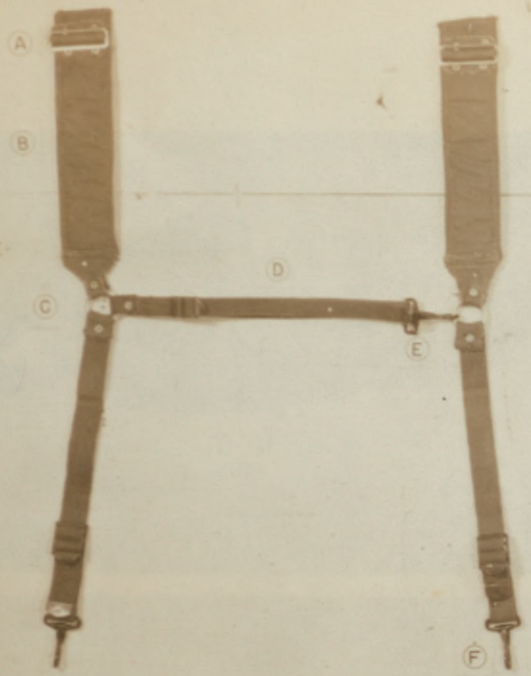


MODIFIED SUSPENDER

A- BUCKLE FOR ATTACHMENT TO TOP OF PACK, PERMITTING ADJUSTMENT OF CHEST STRAP LEVEL.

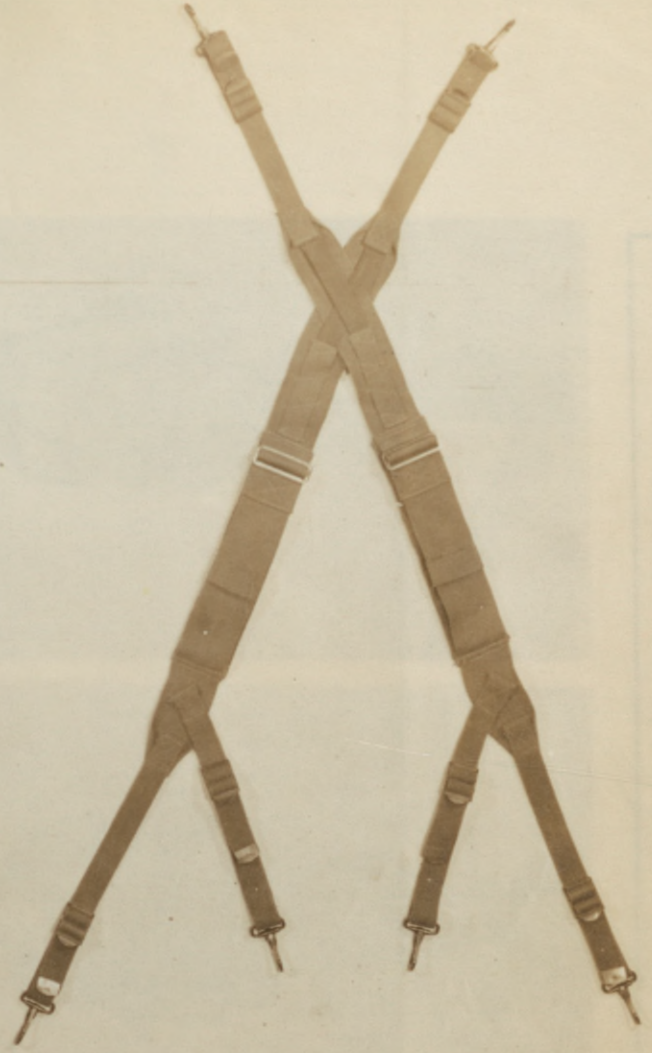
B- SHOULDER PAD.

C- RING FOR AUTOMATIC UNIVERSAL ADJUSTMENT.

D- CHEST STRAP.

E- SNAP HOOK FOR RAPID REMOVAL OF PACK.

F- SNAP FOR ATTACHMENT TO BOTTOM OF PACK.



SUSPENDER PACK FIELD CARGO AND COMBAT
TYPE-7

Comparison of Modified Suspender with
Suspender, Pack, Field, Cargo and Combat, Type 7
ARMORED MEDICAL RESEARCH LABORATORY
FORT KNOX, KY.

Project No. T-1

Photo No. 1

Pack, Field, Combat and Cargo, Supported by
Suspender Type 7 - Above Modified Suspender - Below

ARMORED MEDICAL RESEARCH LABORATORY
FORT KNOX, KY.

Project No. T-1 Photo No. 2