

## CHAPTER V. DEVELOPMENTS IN DESIGN

Liner Not of Static Design---The liner for Helmet, steel M-1, is one of those supply items which did not remain static in design after the first experimental stages of the fiber item had passed. Although it might logically have been decided that the hat, when it was made in plastic form, should be tried out on the field for awhile before further changes were made, the history of the item in the Military Planning Division of the Office of The Quartermaster General is a different story. From the source material, it would seem as if the design of the helmet liner since the beginning of the War has been changed as frequently as a new improvement looked likely to add to soldier comfort.

The biggest change in the liner was the change from fiber to plastic construction for the shell. Utilization of phenolic resin-impregnated duok in place of the pressed paper made the liner incomparably stronger as a head protection against shot and shell, and gave it a longer life for ordinary wear. It was, moreover, cleaner and better appearing.

The first plastic liners, however---those made under contracts signed before April 1942---showed many unsatisfactory points of which the Military Planning Division was well aware, and had been trying to improve for at least six months. Among the faults were the following: The chin strap, installed for permanence, tended to "bake" in the delousing operation, so that it was completely

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ruined and resembled charred bacon. The buckle on the chin strap was too hard to adjust, and was also insecure. The rayon webbing used in the suspension tended to stretch, which destroyed the fit of the hat. The washers used to secure the suspension to the hat were of such shape and so placed as to hurt the wearer's head. The paint coating was unsatisfactory, chipping and marring, so that it permitted bright spots to appear which would reflect dangerously on the battlefield to observers from the air. The most outstanding fault, perhaps, was the requirement of a headband of 13 sizes which was held to the suspension by six sets of snaps to enable liner fit to any size of head, and the vari-sized neckband which aided in this function. Not only was it a decided disadvantage to have to stock the large number of sizes of headband,<sup>1</sup> but to the individual wearer the snap fasteners brought a painful pressure on the head.<sup>2</sup>

Attempts to remedy the faults of the liner were made through many and long conferences between industry and the Research and

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<sup>1</sup>In March 1944, long after the adjustable headband had been in procurement, a stock of 5,000 headbands, size 7-7/8, remained on hand at the Chicago Depot. The tariff on this size was 2 to 1,000 which would make the supply of 5,000 sufficient for an army of 10,000,000 men.

<sup>2</sup>Improved liner suspensions and chin straps were contemplated when the first service tests of the fiber liner were arranged in 1941, according to a memorandum from Brig. General Corbin to the Assistant Chief of Staff G-4, Dec. 20, 1941, which said in part: "Present indications are that improved performance and decrease in weight of the suspension can be obtained."

Development Branch of the Military Planning Division<sup>3</sup> in Washington and representatives of the Chicago Quartermaster Depot engaged in the procurement function. Such meetings took place for nearly two years, beginning in the fall of 1941 when the liner shell itself was in the experimental stages. Out of them, with the benefit of research on the various troublesome items by industry and Quartermaster Corps alike, came a series of improvements which are reflected in the various revisions of specifications. The names of numerous individuals from the companies supplying liner parts would enter into a detailed account of the ideas that led up to these improvements, provided verbatim recordings of the conversations in Washington had been kept. It must suffice, however, to mention a few of the companies only to indicate how inventiveness with regard to their special product played a part.

The Adjustable Headband---The adjustable headband which obviated the need for stocking 13 sizes to fit the suspension was a case in point. At the suggestion of Garnett C. Skinner, manager of the Scholl Manufacturing Company, maker of orthopedic supplies, which was one of the companies called into early conferences on the helmet liner in October 1941, the Research and Development Branch of the Office of The Quartermaster General asked all interested manufacturers to submit samples of an adjustable headband to replace the

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<sup>3</sup>The Research and Development Branch took over work performed by the Standardization Branch in the earlier days of helmet liner development.

one fastened by six double snap fasteners. The experiments that followed brought forth many ingenious results. Some involved zippers and zipper locks, others intricate leather strapping; but as it happened, the headband devised by the Scholl company, which was made adjustable merely by a bar buckle,<sup>4</sup> proved the most successful. An important part of the Scholl headband was the hardware that clipped it to the suspension, and this also was developed by the company from an idea Mr. Skinner conceived while looking at a safety-match pack with its simple closing. At the same time, the manager of the Scholl company put his mind to work on the chin strap fastening, which was a cumbersome affair similar to one used in the German helmet. As a substitute, a buckle whose design had been suggested by the buckle on the safety strap of airplanes was made up on miniature scale and submitted to the Standardization Branch of the Office of The Quartermaster General. Both designs were approved, tentatively, so the Scholl company went into production immediately, and Maj. Lyle Clough of the Office of The Quartermaster General received the first carton of the liners with the new attachments on January 29, 1942.<sup>5</sup>

Other manufacturers whose names appear on the list of those aiding in improving the liner are the Westinghouse Electric Company,

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<sup>4</sup>Instead of the headband being made in one circular piece, it was fashioned like a belt, with one end passing through a bar buckle fastened at the other end, and pushed back through, to enable adjustment to various sized heads.

<sup>5</sup>The Scholl Mfg. Co., which received the Army-Navy "E" award for its war production efforts on various Army items in addition to liner parts, was sent a letter of appreciation by the Quartermaster General, Maj. Gen. E. B. Gregory, for "intelligent and constructive assistance" in bringing the liner suspension to its improved state and making it a "more comfortable article of equipment," as well as saving "time, labor, shipping space, storage facilities, and paper work." Gregory to the Scholl company, Dec. 31, 1942.

which developed the A-shaped washer that replaced the perpendicular-sided metal washers fastening in the early style suspension; the United Carr Fastener Company, which developed the garter stud and hook that enabled well-secured yet removable chin straps; and the North & Judd Manufacturing Company, which had a hand in working out other hardware parts.<sup>6,7</sup> The textured paint coating, and the method of applying it, which came into use after six months of plastic liner production, was perfected by the Forbes Varnish Company of Cleveland, Ohio,<sup>8</sup> while

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<sup>6</sup>Interview with Mr. Skinner.

<sup>7</sup>Among other manufacturers who contributed ideas for improving the liner which did not gain final acceptance was the Paul K. Weil Co., St. Louis glove manufacturer, who with Inspector Lim worked up a headband and suspension that would have replaced the metal hardware with leather.

<sup>8</sup>Originally it was thought that an ordinary lustreless olive drab enamel would provide a satisfactory coating for the helmet liners, and the Forbes company, with other paint firms, supplied quantities of this material to liner manufacturers through the summer of 1942. Following a conference called by the OQMG in Washington because of reports that the enamel finish was not completely satisfactory, the Forbes company began to explore the possibilities of various substances which would produce a textured effect, desired because it was less light reflective and adhered better; walnut shell flour, oyster shell flour and other substances were used in these experiments, with Micarta dust or Durez, both resin dusts, proving the best for the purpose. The Inland Manufacturing Company was first to try the new Forbes textured olive drab paint in October 1942; later Westinghouse, Firestone, Seaman Paper and the other contractors came to use the Forbes paint, which after experimentation was found to be superior to material supplied by competitors. The formulation suiting the varying conditions of production in all contractors' plants was standardized by the Forbes company by March 1943, and maintaining careful control of the paint in production remained the chief problem. The problem of evolving a textured finish for the plastic helmet was principally complicated by the fact that the paint was an application to a molded plastic and the production speed was so high that little time was allowed for baking the finish. The vehicle decided upon consisted of three different alkyd resins---a linseed oil glyceryl phthalic anhydride, a linseed oil-dehydrated castor oil alkyd, and a straight dehydrated castor oil alkyd resin. Solvents used were principally solvent naphtha, solvesso xylol and D.C. naphtha. All three alkyds were blended with a resin modification which is a maleic resin castor (cont'd.)

the Westinghouse Electric & Manufacturing Company worked out the camouflage covering for the liners used for jungle troops.<sup>9</sup> From the Chicago Depot itself came the recommendation that the chin strap be made removable, that the shoestring in the suspension be tightened to give added protection in missile impact, and that tubular rivets be used to hold the suspension in place because they would reduce the amount of echo,<sup>10</sup> which had caused disturbance under field conditions.<sup>11</sup> The Chicago Depot also suggested an adjustable neckband, made so by a bar buckle, which would be installed as a permanent part of the liner and would eliminate the three sizes of neckband in use.

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oil varnish; some melamine and urea formaldehyde resin also were used. Thus, while the finish was primarily an alkyd, it was modified to the point of being a definite departure from the regulation olive drab enamels. Letter from the Forbes Varnish Company, Mar. 23, 1944.

<sup>9</sup>The camouflage coating was applied by airbrush through templates, a kind of stencilling process. Approximately 10,000 liners could be camouflaged a day. A total of 854,225 camouflaged liners was procured in 1942 and 1943 at unit prices ranging from \$1.37 to \$1.77. The liners to be camouflaged were selected by the Westinghouse company and represented portions of contracts for plain liners; therefore were not an additional number. In March 1944, CQMD was informed to discontinue procurement of the camouflaged liners and to have some 300,000 of them already camouflaged, repainted olive drab (unit cost, approximately \$0.12). At the same time the procurement of camouflaged steel helmets was discontinued. The reason given at the Depot was that use of nets to cover the liner or the steel helmet was found to be more effective camouflage protection. Interview with Major Pratt.

<sup>10</sup>Report by Major Pratt to Major Florsheim, OQMG, no date.

<sup>11</sup>The tendency of the helmet liner to echo, or ring, under gunfire, was studied in the Bell acoustical engineering laboratories without effective solution being reached. Troops in the field met the difficulty by stuffing toilet paper between the headband and the top of the liner. Memorandum, Dill, Special Forces Section, to Test and Review Section, OQMG, Special Forces Reading File, June 25, 1943.

As of March 1944, this suggestion was still under consideration by the Military Planning Division in Washington.<sup>12</sup>

Minor changes, such as the clicking out of the leather around the clips fastening headband to suspension, in order to make a smoother surface where the harness touched the head, were comparatively frequent, and when they occurred resulted in some slight change in specifications. Changes which occurred a whole year after the major revisions included the discontinuance of size-treated webbing in the suspension, headband and neckband because it was found to cause discomfort to some wearers and required testing for toxicity;<sup>13</sup> addition of a roller on the chin strap buckle so it would admit any thickness of strap; and the placing of a little burr on the end of the holding clip, to make it fasten more securely.<sup>14</sup> The purpose of all changes was to produce the helmet as more than a protective head covering; to make it a really comfortable "hat."<sup>15</sup>

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<sup>12</sup>Interview with Major Pratt.

<sup>13</sup>Letter to liner, headband and neckband manufacturers and inspectors from CQMD, April 8, 1943.

<sup>14</sup>Telephone Conversation, Major Pratt, CQMD-Mr. Halleck, OCMG, Mar. 18, 1943.

<sup>15</sup>Attempts to ventilate or otherwise cool the helmet liner, to make it more acceptable for use in the tropics, were made following field tests by the Desert Warfare Board in April 1942. A thin sheet of aluminum foil, placed inside the top of the liner, served to deflect some heat, but use of the foil was discouraged by the Surgeon General's Office on the ground that bits of aluminum would complicate head wounds suffered through the liner. Holes punched in the liner shell offered an obvious means of ventilation, but took away waterproof qualities, and were of no use when the steel helmet was worn over the liner. When cork became available in quantities, following Allied occupation of North Africa, it was considered as a possible means of insulation for the liner. However, improvement in the suspension of the liner at the time provided somewhat better ventilation, and to date of this writing, no changes in design pursuant to ventilation have been made. Thomas M. Pitkin, Quartermaster Equipment for Special Forces (QMC Historical Series No. 5, OCMG, February 1944) pp. 173-174, citing Desert Warfare Board report, "M1 Helmet Liners," June 22, 1942; Colonel Hester and Major Robinson, "Report of Inspection"; Wulsin Diary.

The Parachutist Liner--The parachutist liner for airborne troops was an adaptation conceived in the days of the fiber liners; it was worked out by the Research & Development Branch of Military Planning in the Office of The Quartermaster General, the Chicago Quartermaster Depot and various industrial firms. Differing from the ordinary helmet assembly, the steel helmet and liner adopted for paratroops carries a chin strap on the steel helmet which clips into an attachment on the liner, to prevent the wearer's losing the steel hat if he turns upside down; on the liner there is an additional strap with a chin cup besides the regular leather chin strap. The first liner used for the parachutist assembly was the Hawley fiber product, which was modified for the purpose by the McCord Radiator Company. When the plastic liner was introduced the Inland Division of the General Motors Company turned out the first models, approximately 75,000 liners. Later, the Westinghouse company was assigned their manufacture, and at this writing was the sole contractor for this item. Specifications for the parachutist<sup>16</sup> were issued in July 1942<sup>16</sup> and in general followed closely those written for the ordinary liner, except for the directions for forming the molded chin strap with the chamois lining.<sup>17</sup> Weight of the parachutist

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<sup>16</sup>Copy in Appendix III.

<sup>17</sup>The chamois chin cup was changed to a cup and strap fashioned of webbing in a procurement of spring, 1944, when 40,000 of these straps were purchased from a sample supplied by the Military Planning Division of the OQMG, no specifications having been issued at the time. The web chin strap cost \$0.16 a unit, in contrast to \$0.28, cost of the strap with the chamois chin cup. Interview with Major Pratt.



liner was permitted to go up to 12 ounces with suspension, rivets, chin strap, neck suspension installed, whereas the maximum weight of the ordinary helmet liner could not exceed 10 ounces. The parachutist liner was considered a "modification" of the ordinary liner, and, as in the case of the camouflaged hats, when procurement directives were issued by the Office of The Quartermaster General, the number of parachutist liners needed was diverted from orders already in process of being filled.

Major Specification Changes---An analysis of the specifications over the two-year period from February 1942, when the first specification was written by the Chicago Quartermaster Depot, to February 1944, shows that the specifications on the liner, complete, were changed four times, while there were many more small additions, relaxations or other changes.<sup>18</sup> Separate specifications were written for the headband and neckband with the revision of the first Quartermaster Specification, No. 42.<sup>19</sup> This was done because the headbands and neckbands were to be procured separately and from sources different than those supplying the liner shells.<sup>20</sup>

<sup>18</sup>The entire list of specifications, including the first one issued by the Ordnance Department, was as follows: Ordnance Department AIS 644: Lining, Helmet, Assembly for Helmet, Steel M-1, Oct. 30, 1941; OQMG No. 42: Liner, Helmet, M-1, Feb. 13, 1942; CQD 65: Liner, Helmet, M-1, June 20, 1942; CQD 65A: Liner, Helmet, M-1, July 17, 1942; CQD No. 65B: Liner, Helmet, M-1, Aug. 2, 1943. Specifications in force at this writing, March 1944, appear in Appendix III. Drawings referred to in the specifications may be found in the pocket of back cover.

<sup>19</sup>Designation and dates are as follows: CQD No. 63: Head-Band, Assembly for Liner, Helmet, M-1, June 11, 1942; Amendment-1 to CQD No. 63: June 11, 1942; CQD 63A: Head-Band Assembly, July 17, 1942; CQD No. 63B: Head-Band Assembly, Oct. 6, 1943; CQD 63C: Band, Liner, Helmet, M-1, Head, New Type, Feb. 10, 1944.

<sup>20</sup>Lt. Col. C. N. Elliott, COMD, to OQMG, July 4, 1942: Specifications, Revision of Liner, Helmet, M-1.

The first Quartermaster Corps specification on the helmet liner was much more loosely written than those which appeared later, which is understandable, since when the first description was being written not all of the desirable characteristics in a finished liner were recognized. Where the earliest specifications numbered 9 pages of single-space type, the version of October 1943 ran to 16. Even between the time of preparing the specifications of February 1942 and those of June 1942, much more detailed requirements had been added with respect to the metal components, and the maximum weight of the finished liner, complete, had been reduced from  $11\frac{1}{2}$  to 10 ounces. By this time, also, detailed requirements on the suspension assembly and neckband suspension had been determined and were included in the specification. Substitutions permissible in case of shortages on the calfskin<sup>21</sup> and snap fasteners<sup>22</sup> also were mentioned. Specifications on the liner dated July 17, 1942, which followed those of June 20, indicate the difficulties that had arisen with the paint coating, which tended to flake off as soon as the liner went into use.<sup>23</sup> Before long,

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<sup>21</sup>H-3a(1). When, in the opinion of the contracting officer, there is insufficient supply of calfskin available, whole kips up to 21 feet over-all may be substituted. In the event, there is neither a sufficient supply of calfskin nor kips available, then extreme sides, not to exceed  $21\frac{3}{4}$  feet, may be substituted, providing the requirements herein for calfskin are complied with." CQD No. 65; June 20, 1942.

<sup>22</sup>Though steel fasteners were specified, replacing the brass of the original specification, fasteners made of brass on hand were permitted as a substitute. Par. H-3b in CQD No. 65; June 20, 1942.

<sup>23</sup>"The exterior surface of liner body, prior to coating, shall be lightly scuffed, or sanded, to prepare the surface for proper adhesion of coating." Par. E-5 in CQD No. 65, July 17, 1942.

there was even an amendment to the requirement that "the coating on the outer surface" should be "smooth, dull, non-light-reflecting, and suitably resistant to abrasion and scuffing,"<sup>24</sup> to the effect the finish should be "textured," and that "it shall not be possible to furrow off the coating from the top section of the liner with the thumb-nail, and shall not be possible to readily nick through the coating to the liner body, by means of a quarter."<sup>25</sup> There were also several exacting tests added to determine the amount of gloss in the finish.<sup>26</sup> CQD No. 65B, issued August 2, 1943, embraced all the changes which had been incorporated by revision into the previous specification, and brought together three long-standing substitution possibilities---for calfskin, webbing and finish on clips.

Main changes occurring in the headband and neckband specifications related to the adoption of the adjustable feature in the former and the change of sizes in the latter. When the snap-fastened headband was redesigned to eliminate tariff sizes through utilization of the band with the bar-buckle, the system of clip-fastening the headband to the suspension introduced the new hardware and other elements described in the previous chapter.<sup>27</sup> The change in the neckband specifications was scarcely more than a change in nomenclature,

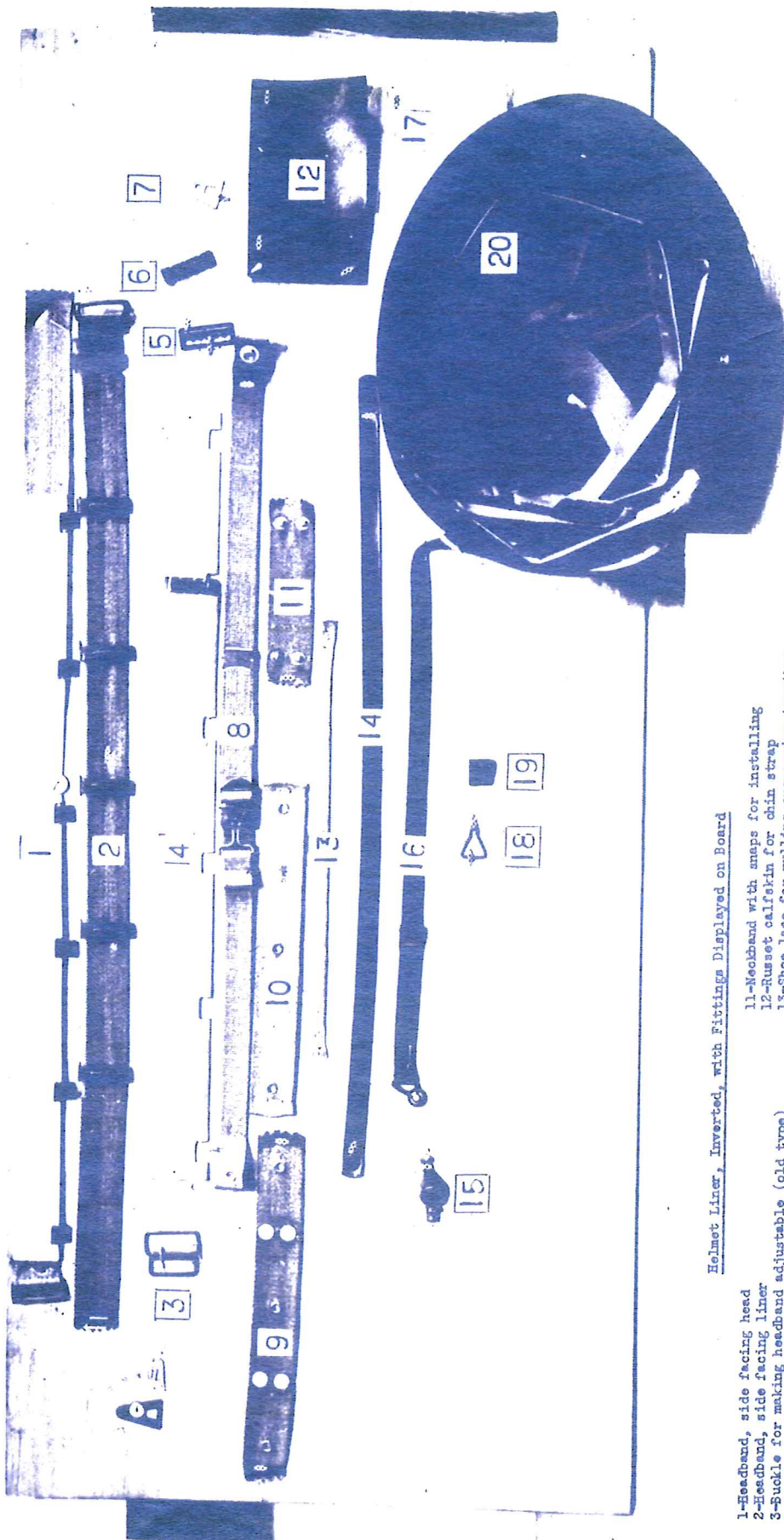
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<sup>24</sup>Par. E-6 in CQD No. 65, July 17, 1942.

<sup>25</sup>Revision to Tentative Specification CQD No. 65A, no date, though probably July 1942.

<sup>26</sup>Ibid.

<sup>27</sup>See drawings in envelope inside back cover, and illustration following.



Helmet Liner, Inverted, with Fittings Displayed on Board

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| 1-Headband, side facing head   | 11-Neckband with snaps for installing                      |
| 2-Headband, side facing liner  | 12-Russet calfskin for chin strap                          |
| 3-Buckle for making headband adjustable (old type)                               | 13-Shoe lace for pulling suspension together               |
| 4-Leather portion of headband with one clip in place for attaching to suspension | 14-Chin strap without attachments                          |
| 5-Bar buckle for adjusting headband  | 15-Bullet for testing steel helmet and liner assembly      |
| 6-Clip for attaching headband to suspension                                      | 16-Chin strap with garter stud and holder and wedge buckle |
| 7-Washer for attaching suspension to liner shell                                 | 17-Natural calfskin for headband                           |
| 8-Chin strap for steel helmet  | 18-Chin strap holder                                       |
| 9-Backstrap of head suspension   | 19-Wedge buckle for adjusting chin strap                   |
| 10-Suspension webbing  | 20-Liner, assembled  |

sizes being labeled small, medium and large, instead of 2, 3 and 5. During the year previous to this writing various minor revisions in the specifications for these two components took place whenever expediency demanded because of the shortage of certain kinds of materials. Most recent of these was the change from steel to half-hard brass, in all of the metal components except the clips for the headband.<sup>28</sup>

Procedure When Changes in Specifications Occurred---

As might be expected, when changes in specifications were made, it was not always immediately possible to alter production. To avoid wastage of materials bought and sometimes already cut or fashioned for helmet liner parts under previous specifications, the Chicago Quartermaster Depot with consent of Washington permitted completion of the contract according to previous designs where necessary. Thus, when the specifications modifying the suspension and introducing the adjustable headband were issued in the late spring of 1942, the Chicago Depot reported that only about 672,000 of a total quantity of 4,334,000 liners purchased on procurement directives then assigned would be furnished with the new type of suspension. Purchases or commitments had been made by contractors for supplies on the entire remainder. It was obviously to the advantage of the Quartermaster Corps to aid the change-over in design as much as possible, since not

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<sup>28</sup>This information went forward to contractors in a COMD letter of Mar. 7, 1944, preparing them for the change in specifications which they were expected to observe under their present contracts as soon as they could change over, and by June 1944 at the latest.

to do so would be to impede production and give contractors an excuse for delinquency.<sup>29</sup>

Improvements in the liner design also were not in every case possible without some increase in total costs. When the suspension and chin strap were changed to new types in June 1942, several contractors sought increased payment for liners they were to make with the new components under uncompleted contracts. The Inland Manufacturing Division of General Motors reported that the new type suspension and chin strap would increase the unit price by \$0.076, a total increase of \$38,000 in its contract. International Molded Plastics, on a quantity of 160,000 liners, asked an increased unit price of \$0.06, totaling \$9,600, for the same reason.<sup>30</sup>

That changes in design and specifications could be made to improve comfort or to circumvent material shortages during production at all, however, may be taken as a healthy indication. Delivery records on the liner show that it was possible to carry through the changes without disrupting production to any great extent, and without alarming additional costs.

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<sup>29</sup> Elliott to Allesee, 1st Ind., June 20, 1942.

<sup>30</sup> HLS P.D. File No. C-C-22 (42).