NOTE: DOD-STD-2134 has been redesignated as a Design Criteria Standard. The cover page has been changed for Administrative reasons. There are no other changes to this Document.

METRIC

DOD-STD-2134 (SH)
3 AUGUST 1981

DEPARTMENT OF DEFENSE
DESIGN CRITERIA

STORAGE BATTERY ARRANGEMENT FOR MINIMUM STRAY MAGNETIC FIELD (METRIC)

AMSC N/A

FSC 6140

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

DEPARTMENT OF THE NAVY

NAVAL SEA SYSTEMS COMMAND

WASHINGTON, DC 20362

Storage Battery Arrangement for
Minimum Stray Magnetic Field

DOD-STD-2134(SH)

1. This Military Standard is approved for use by the Naval Sea Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Sea Systems Command, SEA 3112, Department of the Navy, Washington, DC 20362, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

CONTENTS

CONTENTS (Continued)

FIGURES

CONTENTS (Continued)

TABLE

1. SCOPE

1.1 Scope. This standard covers the arrangement of storage batteries and the arrangement of connections to storage batteries, in a manner that will reduce the stray magnetic field, produced by the current, through the batteries and their associated connections to a minimum.

1.2 Application. The general requirements of this standard (see section 4) are applicable to the arrangement of all types of storage batteries, where a minimum stray magnetic field is desired. The detailed requirements of this standard (see section 5) are applicable to the arrangement of 6-volt DOD-B-15072 storage batteries aboard minesweepers and submarine lead-acid storage batteries covered by DOD-B-24200 and DOD-B-24541. Requirements specified herein are normally applied during ship construction, overhaul, ship alteration or ship repair. Requirements which are within the ship's capability may be applied by ship's force, as needed.

1.3 Classification. The three-cell, 6-volt battery tray arrangements covered by this standard shall be of the following types:

Type I - When looking down on the top of the tray, with the cells oriented in the vertical direction, and the top cell terminals being negative-positive from left to right, the external negative battery connection shall be made at the top of the tray and the external positive battery connection at the bottom of the tray as shown on figure 1.

Type II - When looking down on the top of the tray, with the cells oriented in the vertical direction, and the top cell terminals being negative-positive from left to right, the external positive battery connection shall be made at the top of the tray and the external negative battery connection at the bottom of the tray as shown on figure 1.

2. REFERENCED DOCUMENTS

Not applicable.

3. DEFINITIONS

3.1 Battery, storage. A storage battery may consist of one cell, one tray of cells, or a number of cells or trays of cells connected in series, parallel, or series-parallel.

3.2 Battery circuit. A battery circuit consists of the battery cells or trays comprising the storage battery, the cells' or trays' intercell connectors, and the bus bars or cables connecting the cells or trays together up to the point where the bus bars or cables are terminated for connection to an external circuit.

3.3 Cell, storage battery. A storage battery cell is a unit consisting of positive and negative plates, separators, cell cover, and electrolyte, properly assembled in a single jar, or one compartment of a monobloc case.

3.4 Current loop. A current loop is a closed electric conductor. It may have one or more turns of any size or shape conductor and may be arranged in any way. A simple current loop is a closed conductor making one turn in a single plane, or alternatively, making a number of turns which are in the same plane or in parallel planes and so close together that to a first approximation they can be considered to be physically coincident in space. More complicated current loops can be resolved into a combination of single current loops.

3.5 Dipole. A dipole consists of a north magnetic pole and a south magnetic pole, separated by a very small distance. The axis of the dipole is along the line between the south and north magnetic poles, with the positive direction being in the direction internally from the south pole to the north pole.

3.6 Intercell connectors, storage battery. Intercell connectors are the electrical conductors which connect one cell to another cell in series, parallel, or series-parallel circuit connection.

3.7 Magnetic moment of a current loop or dipole. The magnetic moment of a current loop is equal to the product of the area enclosed by each turn times the number of turns times the current. The magnetic moment of a dipole shall be equal to the pole strength of the poles times the distance between the poles.

3.8 Parallel compensation. Parallel compensation is two current loops, connected in parallel, carrying the same current and having the same size, shape and number of turns and in the same plane with mirror image symmetry as shown on figure 2.

3.9 Series compensation. Series compensation is achieved when two current loops, connected together in series, have the same size, shape and number of turns and are in the same plane with mirror image symmetry as shown on figure 2.

3.10 Stray magnetic field. A stray magnetic field is the change in the magnetic field outside of a battery, which is caused by changing the current, in the electric circuit containing the battery, from zero to a value different from zero, when all other conditions remain the same.

3.11 Submarine battery cell notation [(4 x n) + r]. The number of cells in a row and in a current loop of a submarine battery shall be indicated by the following notation, where "n" is an integer and "r" is 0, 1, 2, or 3.

Basic notation for total number of cells in a row: [(4 x n) + r]

For r = 0, there are (4 x n) cells in a row and three current loops containing n, (2 x n), and n cells, respectively, in a row.

For r = 1, there are [(4 x n) + 1] cells in a row and three current loops containing n, (2 x n), and (n + 1) cells, respectively, in a row.

For r = 2, there are [(4 x n) + 2] cells in a row and three current loops containing n, [(2 x n) + 1], and (n + 1) cells, respectively, in a row.

For r = 3, there are [(4 x n) + 3] cells in a row and three current loops containing (n + 1), [(2 x n) + 1], and (n + 1) cells, respectively, in a row.

3.12 Tray, storage battery. A storage battery tray consists of one or more cells assembled in a common container or a monobloc case.

4. GENERAL REQUIREMENTS

4.1 Battery tray arrangement and connections. Battery trays comprising a storage battery shall be physically arranged and interconnected in a manner that will result in a battery circuit which will create a minimum stray magnetic field.

4.2 Simplicity of battery circuit arrangement. The battery circuit arrangement that will produce a minimum stray magnetic field shall be accomplished in as simple a manner as possible.

4.3 Arrangement of battery circuit for minimum magnetic moment and minimum magnetic moment separation. Magnetic moments of equal and opposite current loops or dipoles created by the battery circuit shall be as small as possible. The distance between these current loops or dipoles shall be as small as possible.

4.4 Arrangement of battery circuit for minimum net magnetic moment. The resultant or net magnetic moment of all current loops or dipoles created by the battery circuit shall be as close to zero as possible.

4.4.1 Utilization of series and parallel compensation in the arrangement of battery circuit. Series compensation shall be utilized in the arrangement of the battery circuit in order to achieve a minimum net magnetic moment. Parallel compensation shall be utilized in the battery circuit in order to achieve a minimum net magnetic moment only when precautions have been taken to minimize the effects of unequal current division.

4.5 Positioning of battery connecting bus bars. Except for crossover points, the centerlines of the bus bars connected to the battery shall be in the same horizontal plane as the centerlines of the intercell connectors. At crossover points, the bus bar or cables shall depart from this plane only as much as is needed, to provide room for insulation clearance.

4.6 Selection of connecting bus bars. Bus bars shall be used for connecting battery trays together, in order to facilitate the fabrication and maintenance of equal area current loops.

4.7 External battery circuit connections. External battery circuit connections shall be made so as to minimize the creation of stray magnetic fields.

4.8 External battery circuit arrangements. External battery circuit arrangements shall be such as to minimize the creation of stray magnetic fields.

4.9 Battery arrangement warning plates. Battery arrangement warning plates shall show the physical arrangement of and connections to the battery trays. The plates shall be installed as close as practicable to the applicable battery. Table I lists the type of battery arrangement and the NAVSEA number of the applicable warning plates. The figures of this standard correspond to the battery arrangement shown on the warning plates.

TABLE I. Battery arrangement warning plates.

Battery type	NAVSEA No.	Figure No.
108-volt battery connection arrangement	250-660-77-1	8
24-volt battery connection arrangement	250-660-77-2	5A & 5B
12-volt battery connection arrangement	250-660-77-3	4
30-volt battery connection arrangement	250-660-77-4	6
36-volt battery connection arrangement	250-660-77-5	7
24-volt two row battery connection arrangement	250-660-77-6	5C
24-volt two banks in parallel battery connection arrangement	250-660-77-7	5E
24-volt double deck battery connection arrangement	250-660-77-8	5D

5. DETAILED REQUIREMENTS

5.1 Preferred minesweeper storage battery arrangement. The preferred minesweeper storage battery arrangement shall consist of an even number of battery trays, consisting of one-half type I trays and one-half type II trays, arranged and connected such that several small current loops are created with half of the loops having an equal but opposite field from the other half, thus resulting in a minimum total stray magnetic field. Preferred minesweeper storage battery arrangements for batteries shall consist of 2, 4, 5, 6, 8, and 18 6-volt trays (see 5.1.1 through 5.1.6). Deviations from these arrangements shall conform with the general requirements of section 4.

5.1.1 6-volt battery connection arrangement (two trays connected in parallel). A 6-volt battery connection arrangement consisting of two trays connected in parallel shall be in accordance with figure 3.

5.1.2 12-volt battery connection arrangement (two trays). A 12-volt battery connection arrangement consisting of two trays shall be in accordance with figure 4.

5.1.3 24-volt battery connection arrangement (four/eight trays). A 24-volt battery connection arrangement consisting of four (or eight) trays shall be in accordance with one of the arrangements shown on figure 5.

5.1.4 30-volt battery connection arrangement (five trays). A 30-volt battery connection arrangement consisting of five trays shall be in accordance with one of the arrangements shown on figure 6.

5.1.5 36-volt battery connection arrangement (six trays). A 36-volt battery connection arrangement consisting of six trays shall be in accordance with figure 7.

5.1.6 108-volt battery connection arrangement (18 trays). A 108-volt battery connection arrangement shall be in accordance with one of the arrangements shown on figure 8.

5.2 Bus bar to cable external battery circuit connections. External battery circuit cable connections to the bus bar intercell connectors shall be made at the bus bar termination points shown on figures 3 through 8, in accordance with the method shown on figure 9.

5.3 Battery starting circuit cable arrangement. The starting motor and solenoid leads from the intercell battery connection bus bars shall be in accordance with figure 10. Cable connections to the starting solenoid and motor shall be in accordance with figure 10.

5.4 Submarine storage battery arrangement. In order to achieve a small magnetic field, the submarine storage battery arrangement shall be in accordance with the specific requirement of 5.4.1 through 5.4.9.

5.4.1 Preferred number of cells for a submarine storage battery. The order of decreasing preference for the total number of submarine storage battery cells shall be an integral multiple of 32, 16, 8 or 4. A total number of cells that is an odd integral multiple of 2 is undesirable from the stray magnetic field standpoint, and shall require special arrangement considerations.

5.4.2 Preferred total number of rows of cells for a submarine storage battery. The preferred total number of rows of cells for a submarine storage battery, in order of decreasing preference, shall be a multiple of 8, 4 or 2. An odd number of rows shall not be used.

5.4.3 Preferred grouping of rows of cells for a submarine storage battery. The preferred grouping for the rows of cells for a submarine storage battery shall be, in order of decreasing preference, groups of 8 or 4 adjacent rows of equal length.

5.4.4 Preferred [n, (2 x n), n] total number of cells in a row for a submarine storage battery. The preferred total number of cells in a row for a submarine storage battery shall be (4 x n), where n is an integer. Connections between intra-row cells shall be made with the crossovers shown on figure 11, to form three distinct current loops of reversing polarity of n, (2 x n) and n cells long, respectively.

5.4.5 Nonpreferred [(4 x n) + 1] total number of cells in a row for a submarine storage battery. For rows consisting of a total number of cells equal to [(4 x n) + 1], where n is any integer, connections between intra-row cells shall be made with crossovers, in accordance with figure 12A, to form three current loops comprised of n, (2 x n) and (n + 1) cells. Four adjacent rows of cells with [(4 x n) + 1] cells in each row shall be required for a minimum net magnetic moment.

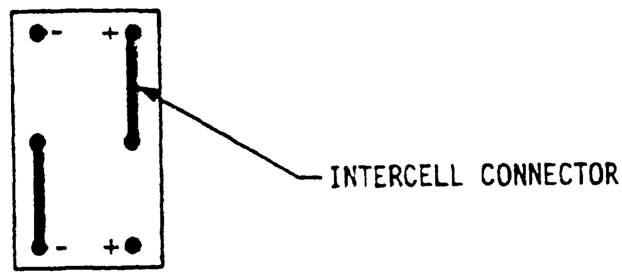
5.4.6 Nonpreferred [(4 x n) + 2] total number of cells in a row for a submarine storage battery. For rows consisting of a total number of cells equal to [(4 x n) + 2], where n is any integer, connections between intrarow cells shall be made with crossovers, in accordance with figure 12B, to form three current loops comprised of n, [(2 x n) + 1] and (n + 1) cells. Two adjacent rows of cells with [(4 x n) + 2] cells in each row shall be required for a minimum net magnetic moment.

5.4.7 Nonpreferred [(4 x n) + 3] total number of cells in a row for a submarine storage battery. For rows consisting of a total number of cells equal to [(4 x n) + 3], where n is any integer, connections between intra-row cells shall be made with crossovers, in accordance with figure 12C, to form three current loops comprised of (n + 1), [(2 x n) + 1] and (n + 1) cells. Four adjacent rows of cells with [(4 x n) + 3] cells in each row shall be required for a minimum net magnetic moment.

5.4.8 Inter-row cell connections for a submarine storage battery. The connections from row to row for a submarine storage battery shall be made as close as possible, to minimize the size of current loops which they form, and shall be made in such a way as to achieve the current loops with the polarities, as shown on figure 11 or 12, as applicable.

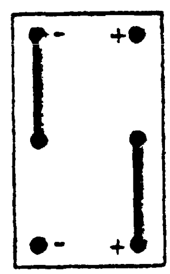
5.4.9 Avoidance of magnetic material in or between current loops produced by the battery circuit in submarine storage batteries. A submarine storage battery circuit shall be arranged to prevent formation of current loops which completely enclose magnetic material. Magnetic material between current loops, produced by the battery circuit, shall be avoided.

Preparing activity:
Navy - SH
(Project 6140-N550)



TYPE I BATTERY TRAY ARRANGEMENT

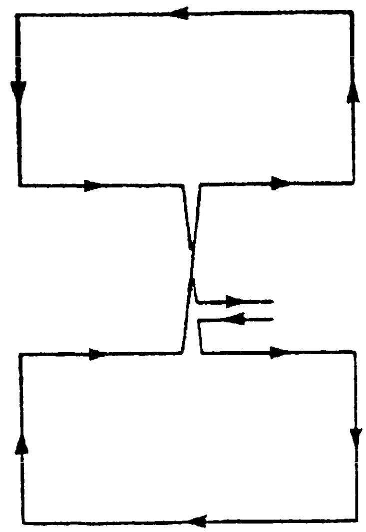
NOTE: A Type I tray can be converted to a Type II tray, or vice versa, by shifting intercell connectors.



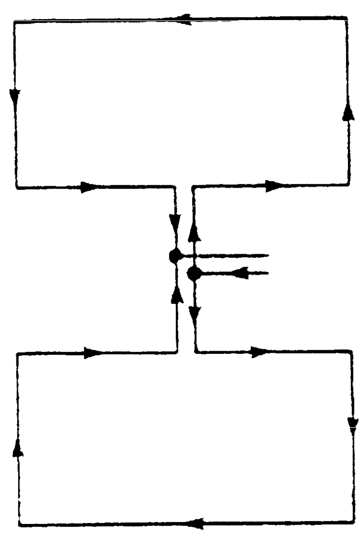
TYPE II BATTERY TRAY ARRANGEMENT

SH 11929

FIGURE 1. Type I and type II battery tray arrangements for three-cell, 6-volt battery trays.



A. SERIES COMPENSATION

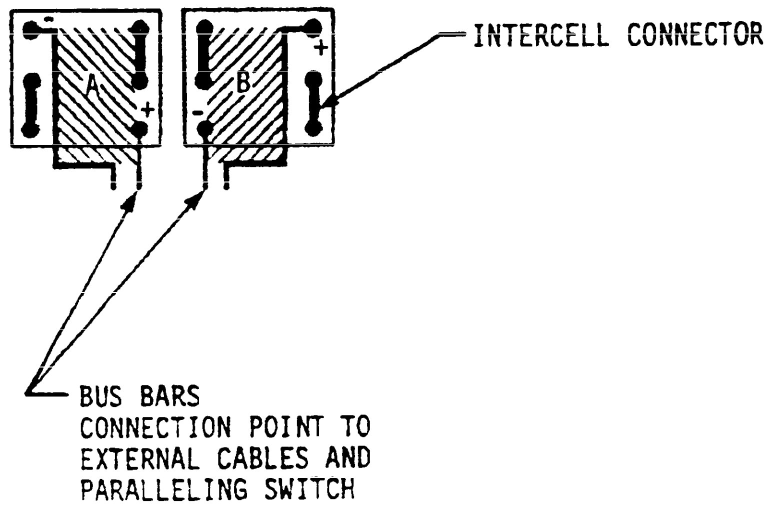


B. PARALLEL COMPENSATION

SH 11930

FIGURE 2. Series and parallel compensating current loops.

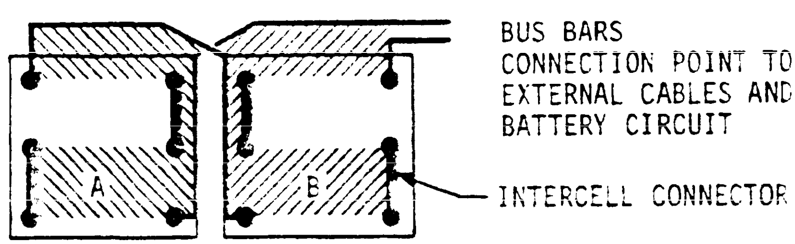
AREA A = AREA B



SH 11931

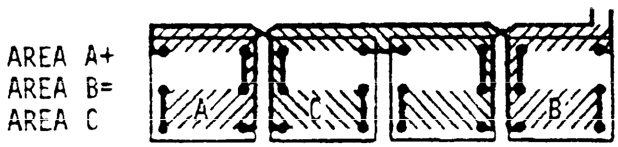
FIGURE 3. 6-volt battery connection arrangement (two trays in parallel).

AREA A = AREA B

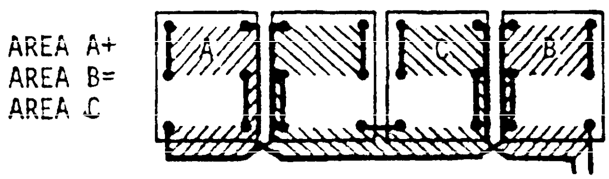


SH 11932

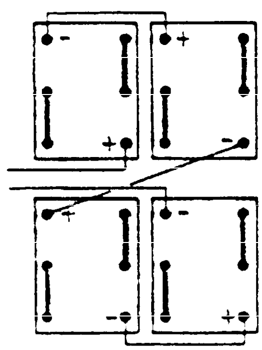
FIGURE 4. 12-volt battery connection arrangement (two trays).

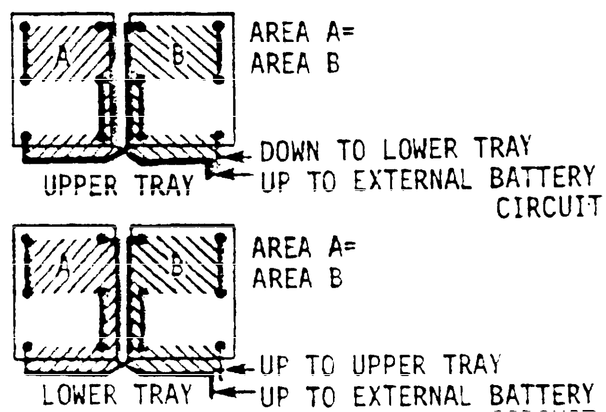


A. ALTERNATING TYPE I AND TYPE II TRAYS

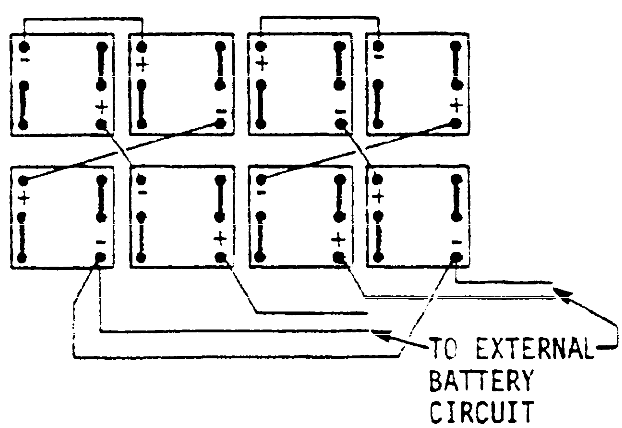


B. ALTERNATING TYPE II' AND TYPE I TRAYS





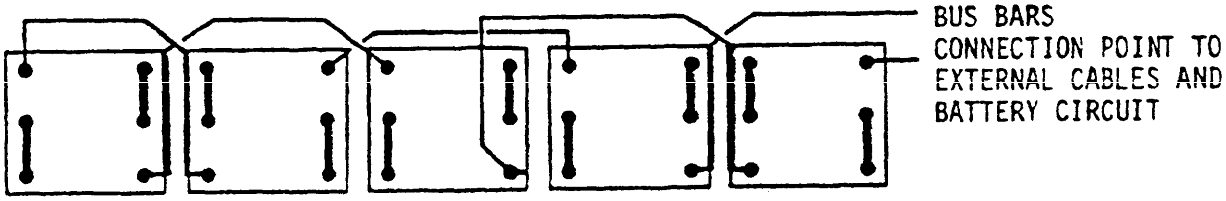
C. TWO ROW ARRANGEMENT D. DOUBLE DECK ARRANGEMENT



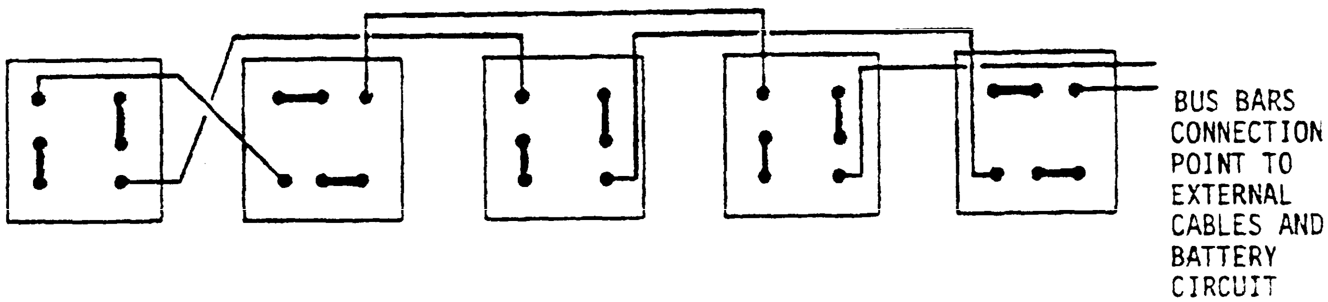
E. TWO BANKS OF 24 VOLT BATTERIES IN PARALLEL

SH 11933

FIGURE 5. 24-volt battery connection arrangements (four/eight trays).



A. TYPE I AND TYPE II BATTERIES (PREFERRED ARRANGEMENT)



B. TYPE I BATTERIES ONLY
NOTE: For use only in circuits which draw small currents.

SH 11934

FIGURE 6. 30-volt battery connection arrangements (five trays).

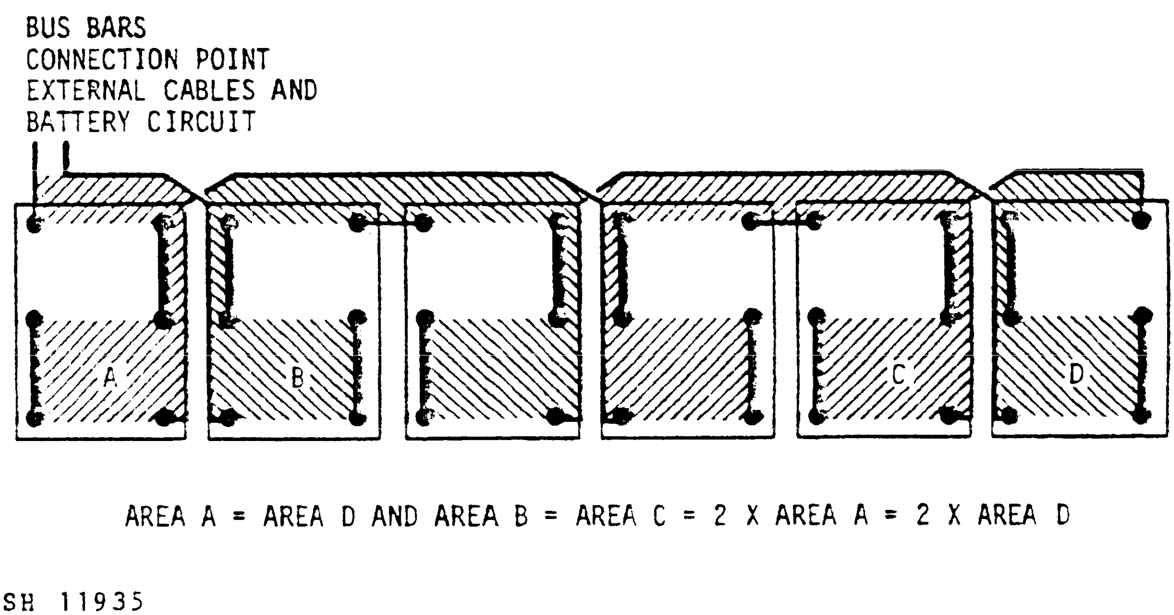
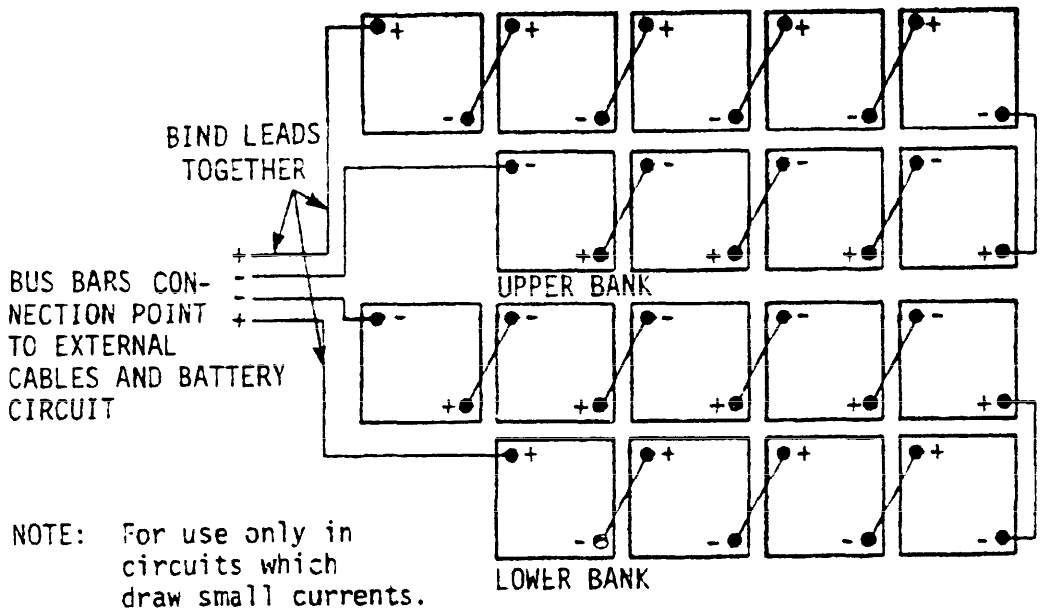
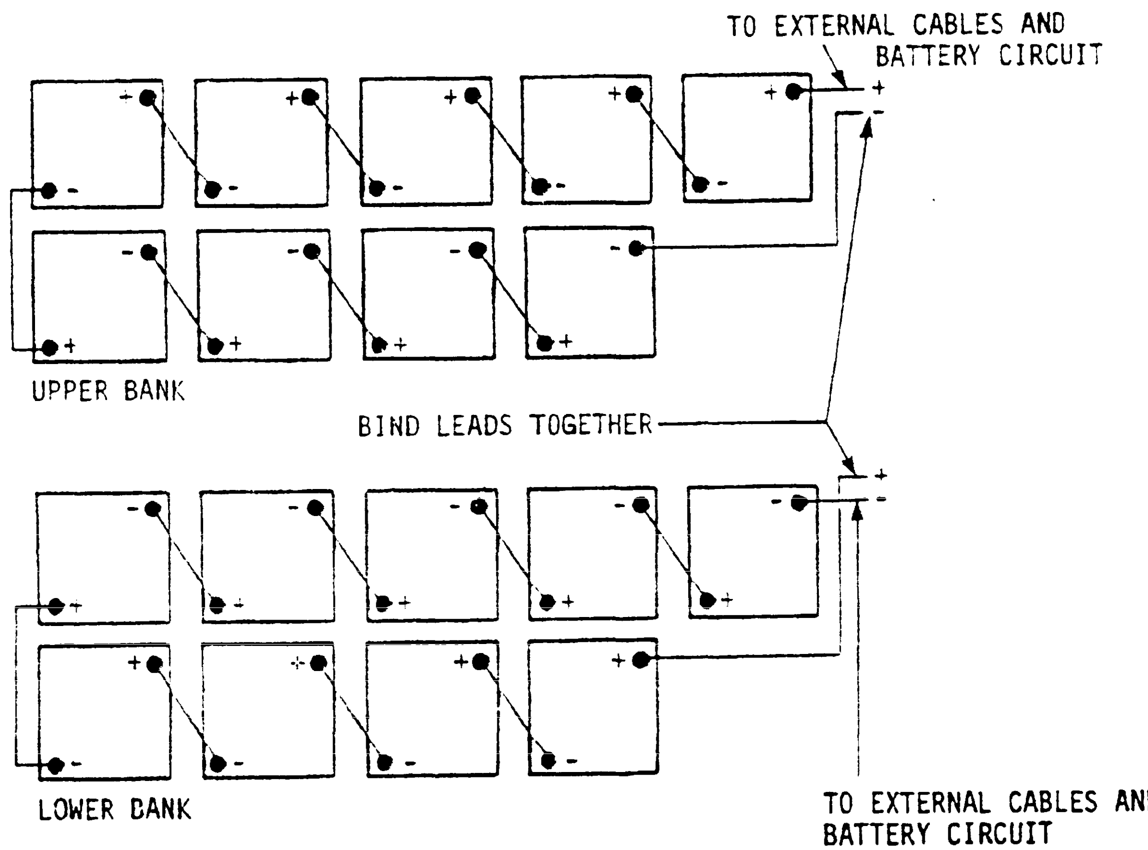


FIGURE 7. 36-volt battery connection arrangement (six trays).



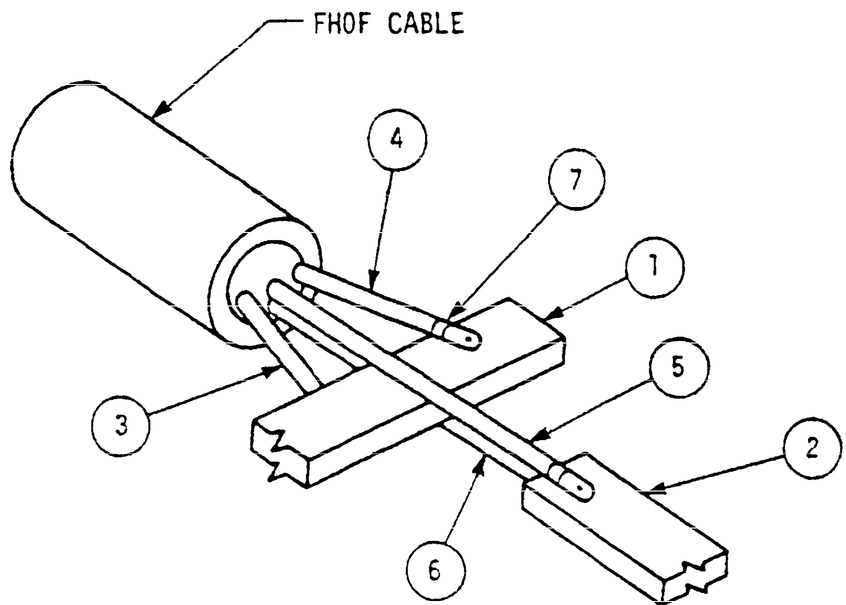
ARRANGEMENT A



ARRANGEMENT B

SH 11936

FIGURE 8. 108-volt battery connection arrangements (18 trays).



1 and 2. Bus Bars

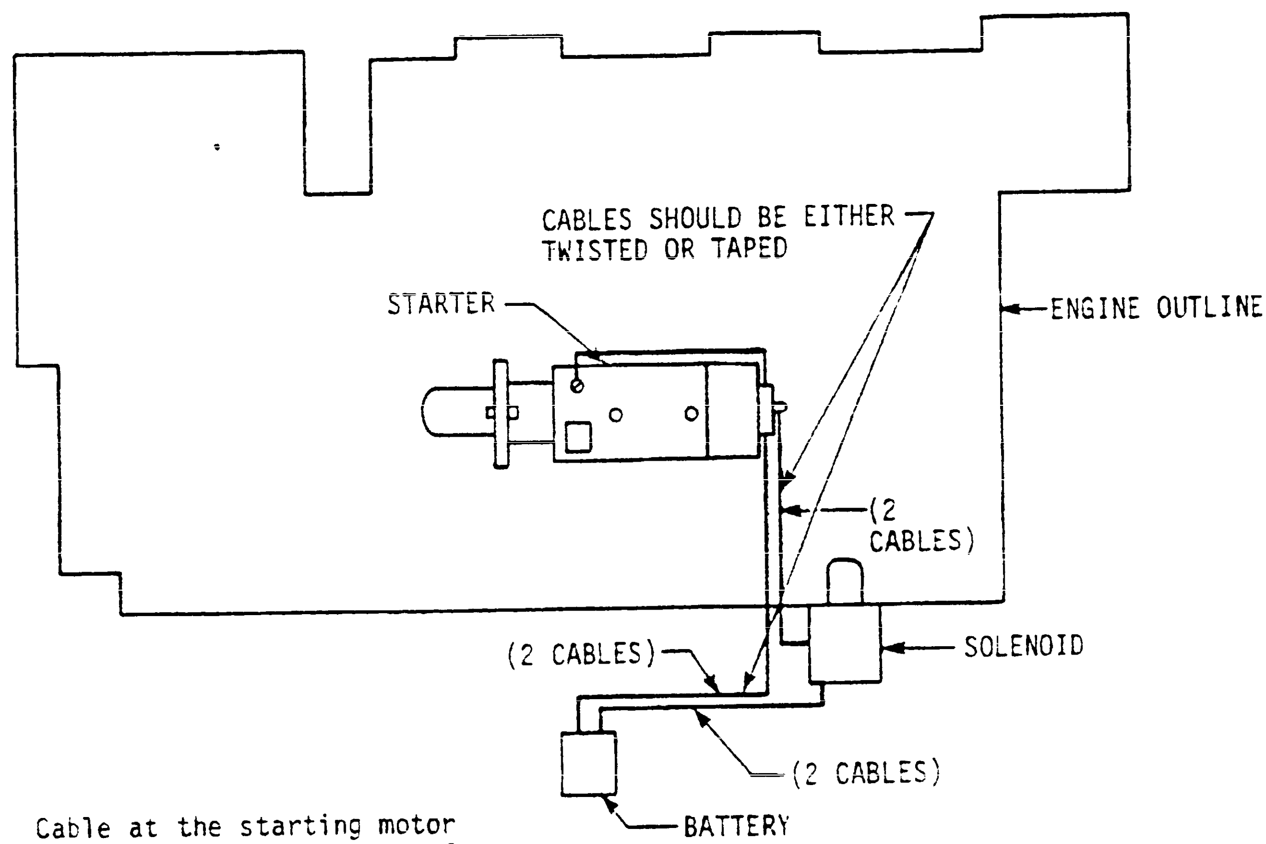
3 and 4. Diagonally opposite conductors in 4-conductor cable. One to be connected above and one below bus bar 1 at points equidistant from the center line of bus bar 2.

5 and 6. Diagonally opposite conductors in 4-conductor cable. One to pass above and one below bus bar 1 and be connected to upper and lower side of bus bar 2.

7. Cable Lugs

SH 11937

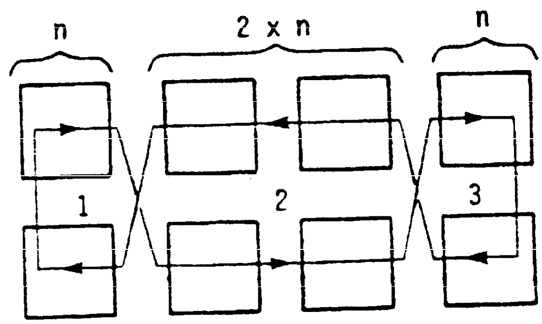
FIGURE 9. Bus bar to cable external battery circuit connections.



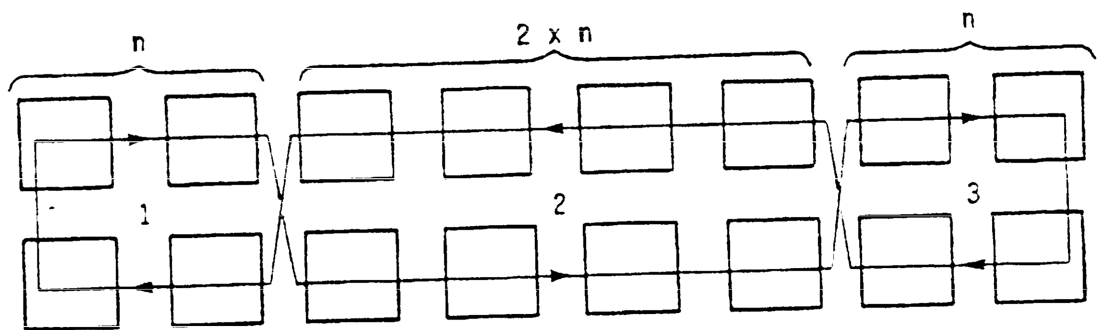
NOTE: Cable at the starting motor shall follow the contour of the motor, thus forming only a small loop with internal wiring of the motor.

SH 11938

FIGURE 10. Battery starting circuit cable arrangement.



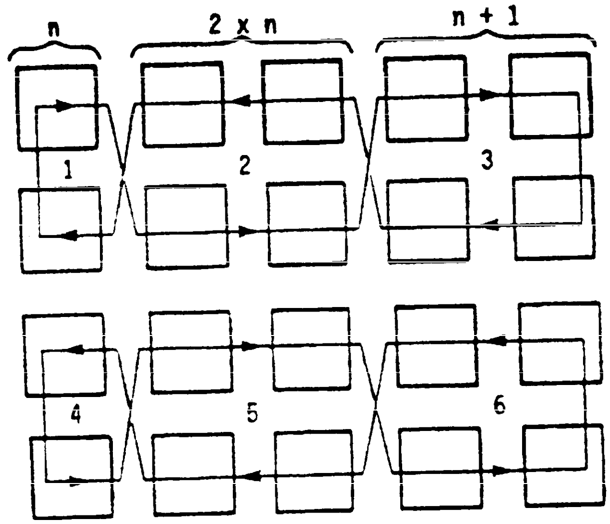
A. 4 CELLS PER ROW (n = 1)
AREA LOOP 1 + AREA LOOP 3 = AREA LOOP 2



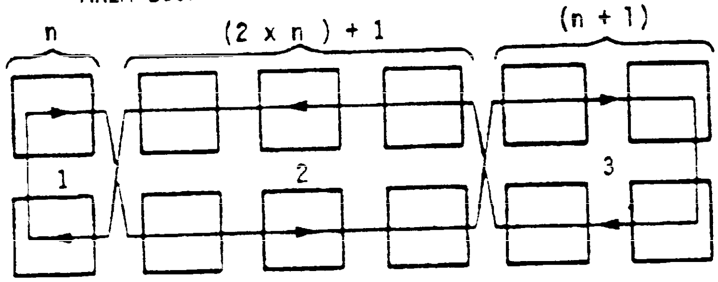
B. 8 CELLS PER ROW (n = 2)
AREA LOOP 1 + AREA LOOP 3 = AREA LOOP 2

SH 11939

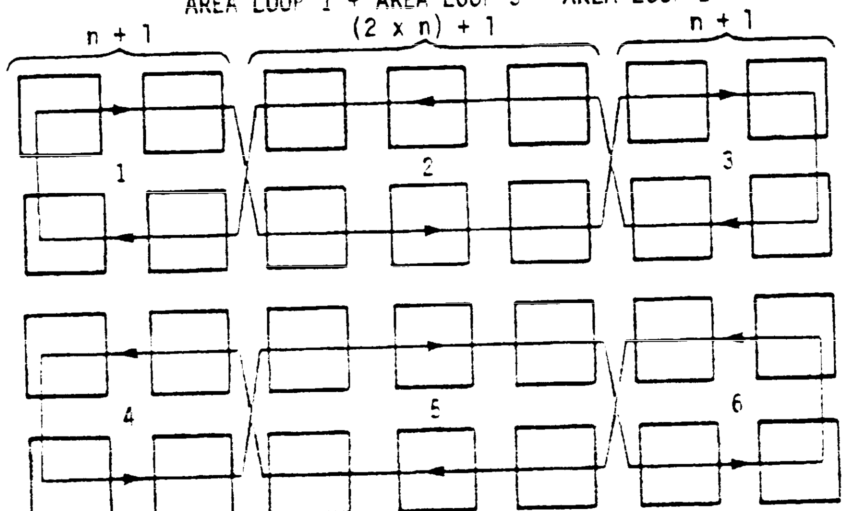
FIGURE 11. Preferred [n, (2 x n), n] battery cell row arrangement for a submarine storage battery.



A. [(4 x n) + r] CELLS PER ROW (n = 1, r = 1; 5 CELLS PER ROW)
AREA LOOP 1 = AREA LOOP 4
AREA LOOP 2 = AREA LOOP 3 = AREA LOOP 5 = AREA LOOP 6



B. [(4 x n) + r] CELLS PER ROW (n = 1, r = 2; 6 CELLS PER ROW)
AREA LOOP 1 + AREA LOOP 3 = AREA LOOP 2



C. [(4 x n) + r] CELLS PER ROW (n = 1, r = 3; 7 CELLS PER ROW)
AREA LOOP 1 = AREA LOOP 3 = AREA LOOP 4 = AREA LOOP 6
AREA LOOP 5 = AREA LOOP 2

SH 11940

FIGURE 12. Nonpreferred [(4 x n) + r] battery cell row arrangements for a submarine storage battery.

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

OMB Approval
No. 22-R255

INSTRUCTIONS: The purpose of this form is to solicit beneficial comments which will help achieve procurement of suitable products at reasonable cost and minimum delay, or will otherwise enhance use of the document. DoD contractors, government activities, or manufacturers/vendors who are prospective suppliers of the product are invited to submit comments to the government. Fold on lines on reverse side, staple in corner, and send to preparing activity. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements. Attach any pertinent data which may be of use in improving this document. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity.

DOCUMENT IDENTIFIER AND TITLE
DOD-STD-2134(SH)

NAME OF ORGANIZATION AND ADDRESS	CONTRACT NUMBER
	MATERIAL PROCURED UNDER A ☐ DIRECT GOVERNMENT CONTRACT ☐ SUBCONTRACT

1. HAS ANY PART OF THE DOCUMENT CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE?
   A. GIVE PARAGRAPH NUMBER AND WORDING.

   B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES

2. COMMENTS ON ANY DOCUMENT REQUIREMENT CONSIDERED TOO RIGID

3. IS THE DOCUMENT RESTRICTIVE?

   ☐ YES ☐ NO *(If "Yes", in what way?)*

4. REMARKS

SUBMITTED BY *(Printed or typed name and address - Optional)*	TELEPHONE NO.
	DATE

DD FORM 1 JAN 72 1426 REPLACES EDITION OF 1 JAN 66 WHICH MAY BE USED S/N 0102-014-1802