This invention relates generally to improvements in high amperage electrical connectors of the male and female type and, with respect to specific applications, to the utilization of the improved connectors in receptacles, plugs, and other connector structures adapted to handle the heavy currents delivered by the storage batteries or alternators associated with the electrical systems of heavy vehicular equipment, marine engines, and other applications where polarity protection is of prime importance.

The primary object of the invention is to provide male and female electrical connectors capable of continuously handling heavy electrical currents on the order of 100 amperes or above and which, furthermore, are less expensive than comparable connectors utilized heretofore.

As a corollary to the foregoing object, it is a broad aim of the instant invention to provide connectors as aforesaid which are readily formed from standard metallic stock and are inherently rugged and capable of withstanding abuse.

A further object of the invention is to provide connectors as aforesaid which facilitate flash butt-welding thereof to electrical conductors to provide either an inline connection with the conductor or a right angle connection therewith as may be dictated by space and clearance considerations or other factors of a given installation.

Additionally, it is a specific object of the instant invention to provide a plug and receptacle combination for use with heavy vehicular equipment for coupling the terminals of the storage battery thereof with either an external source or load, wherein the plug and receptacle structure is arranged such that inadvertent cross-connecting thereof is precluded to protect the alternator or other polarity sensitive apparatus of the equipment.
to facilitate jump starting of a number of such vehicles from a single vehicle once the latter is started, this being effected by providing all of the vehicles with takeoff receptacles 10 and utilizing plugs 18 at each end of a jumper cable comprising the conductors 20 and 22.

The receptacle 10 has a pair of cylindrical male connectors 24 and 26 therein, the connector 24 being shown in detail in FIGS. 5 and 6. It should be understood that the illustration of connector 24 in FIGS. 5 and 6 is illustrative of all of the male connectors shown in the drawing and to be described hereinafter. The male connectors 24 and 26 are encased by the housing 28 of receptacle 10, the housing 28 including a pair of outwardly projecting parallel disposed, tubular cover components 30 and 32 which terminate in axially staggered relationship to each other as is most clearly revealed in FIG. 1. The male connectors 24 and 26 are axially disposed within respective components 30 and 32, the latter extending somewhat beyond the outer ends 34 of connectors 24 and 26 as is shown.

The receptacle housing 28 is of molded construction and may comprise a suitable, structurally strong synthetic resin material having insulating properties. For example, fiber glass reinforced nylon may be utilized, it being noted that the receptacle housing 28 includes a downwardly extending jacket portion 36 enclosing the end stretches of conductors 14 and 16.

The joining of conductors 14 and 16 to the male connectors 24 and 26 is best shown in FIGS. 5 and 6. The connector 24 has a longitudinally extending slit 38 therein communicating with the outer end 34 thereof to define a pair of semicircular contact elements 40 and 42. The opposite or inner end of connector 24 is provided with an integral end section 44 having a square or cube-shaped configuration, thereby presenting a plurality of flats 46 facing in various lateral directions as well as longitudinally rearwardly away from connector 24.

The insulation is removed from the end of conductor 14 and a metallic sleeve 48 is crimped onto the bare end to preclude spreading of the various strands of conductor 14. The end of conductor 14 may engage one of the lateral flats 46 or the rearwardly facing flat 46 as depicted in FIG. 6. It may be appreciated, therefore, that either an in-line or a right angle connection with the male connector 24 may be effected, the right angle connector being chosen for the embodiment of FIGS. 1-4 due to clearance considerations. With the circular end surface presented by the strands of conductor 14 and the end of sleeve 48 abutting the selected flat 46, flash butt-welding is employed to join connector 24 and conductor 14 at the relatively high resistance interface formed by flat 46 and the end of conductor 14 abutting thereagainst.

Since the receptacle housing is molded around the upper stretches of conductors 14 and 16 and the inner end portions of male connectors 24 and 26 and, furthermore, comprises a rigid material, the male connectors 24 and 26 are firmly held by the jacket portion 36 of housing 28 and are maintained in axially disposed relationship to the associated tubular cover components 30 and 32 integral with jacket 36. As an assist in mounting, an integral flange 50 is formed on housing 28 which is illustrated in FIG. 1 flush with the backside of panel 12. An opening (not shown) in panel 12 permits components 30 and 32 to project from panel 12 when housing 28 is bolted in place.

When receptacle 10 is not in use, a protective cap 52 (FIG. 1) may be inserted into tubular components 30 and 32 to seal receptacle 10 against ingress of moisture or the like. Cap 52 includes a pair of parallel, closely spaced, longitudinally staggered barrels 54 and 56 receivable within components 30 and 32 respectively. Both of the barrels 54 and 56 are provided with central bores, the bore 58 of the upper barrel 54 being revealed in the sectional representation in FIG. 1. The bores of both of the barrels 54 and 56 are sized to closely fit with the male connectors 24 and 26 to assist in holding the cap 52 in place. Additionally, a pair of O-rings 60 and 62 are provided adjacent the inner ends of barrels 54 and 56 respectively, the O-rings 60 and 62 being sandwiched between barrels 54 and 56 and components 30 and 32 upon insertion of cap 52 into receptacle 10. The cap 52 is preferably composed of a flexible, insulating, molded synthetic resin material and is retained in position by a tether cable 64 extending between the body of cap 52 and one of the bolts 66 utilized to secure receptacle 10 to panel 12.

With reference to the construction of plug 18, it may be seen that the latter comprises a housing 68 of molded plastic construction, molded vinyl or a similar synthetic resin material being utilized to impart a degree of flexibility to the housing 68. A pair of tubular, female connectors 70 and 72 are disposed within housing 68 in parallel, longitudinally staggered relationship to each other as may be seen in FIG. 4. The female connectors 70 and 72 have solid inner ends flash butt-welded to the ends of conductors 20 and 22 respectively, much in the same manner that the male connectors 24 and 26 are flash butt-welded to the ends of conductors 14 and 16. Flash butt-welding is utilized to join the bare end of each of the conductors to the respective female connector, each one difference being that the inner, solid ends of the female connectors are of cylindrical configuration but may be slightly enlarged in diameter with respect to the tubular portions of the connectors 70 and 72 as illustrated in FIG. 4. Thus, only one flat face for flash butt-welding of the female connectors 70 and 72 to the conductors 20 and 22 is provided since an in-line connection is desired. A sleeve 74 encircles the bare end of each conductor 20 or 22 and is crimped thereon to prevent spreading of the strands of the conductors, and is welded to the associated female connector along with the ends of the wire strands.

The plug housing 68 includes a pair of tubular cover components in the form of sheaths 76 and 78 extending over and conforming to female connectors 70 and 72. It may be seen in FIG. 4 that each of the sheaths 76 or 78 projects beyond the open end of the female connectors 70 or 72 and presents an inturnd, annular lip 80. The plug housing 68 also has a jacket portion 82 forming the main body thereof which envelopes the welded joints and adjacent end stretches of conductors 20 and 22 to provide both an insulating covering and serve as a support for female connectors 70 and 72 and conductors 20 and 22 to hold the same in proper controlled interrelationship.

In order to assure that the female connectors 70 and 72 will not shift within the body of plug housing 68, the enlargements at the inner ends of connectors 70 and 72 are provided as mentioned above and, additionally, each of the connectors 70 and 72 is provided with an annular recess 84 which is filled by the housing material during molding.

A pair of O-rings 86 and 88 surrounds sheaths 76 and 78 adjacent their inner ends to provide a moistureproof seal when plug 18 is inserted into receptacle 10. A latch projection 90 is formed on the underside of sheath 76 and slips over an upwardly extending latch projection 92, formed on the top of the tubular component 32 of receptacle housing 28, when plug 18 is inserted into receptacle 10.

Referring to the second form of the invention illustrated in FIGS. 7 and 8, a storage battery 94 is shown fragmentarily and has a pair of opposite polarity terminals 96 and 98. A pair of terminal clamps 100 and 102 embrace terminals 96 and 98 and are held tightly thereagainst by their drawbolts 104 and 106. Through clamps 100 and 102, and quick disconnect coupling structure to be described, terminals 96 and 98 are electrically connected with a pair of stranded, insulated electrical conductors 108 and 110 respectively. If an alternator (not shown) is utilized to charge battery 94, such as in marine
or automotive applications, then it is requisite that cross-connecting of terminals 96 and 98 with conductors 108 and 110 be precluded in order to avoid damage to the alternator.

The details of the disconnect structure associated with terminal clamps 108 and 110 are illustrated in FIG. 8. The clamp 108 terminates in a solid shank 112, a cylindrical male connector 114 being welded to shank 112 in axial alignment therewith. The male connector 114 has an outer end 116 and an enlarged, inner end section 118 of cylindrical configuration. The male connector 114 is also provided with a longitudinally extending slit 120 and these, projects to the male connector 24 illustrated in detail in FIGS. 5 and 6, except for the provision of the cylindrical end section 118. The polygonal end section with accompanying flats is not utilized in the embodiment of FIGS. 7 and 8 since the arrangement is best suited to an in-line connection with shank 112.

The insulation is removed from the end of conductor 108 and a metallic sleeve 122 is cramped in place thereon, such end and sleeve 122 being welded to a tubular female connector 124 shown telescope over the male connector 114. The female connector 124 has a solid or closed end portion 126 which presents a flat end surface for forming the welded joint with the end of conductor 108 and sleeve 122.

A tubular cover component 128, preferably of molded vinyl construction, is slipped over male connector 114 or molded therearound and onto shank 112. A tubular sheath 130 of like composition is slipped or molded over the female connector 124 and envelops the welded joint and the adjacent end stretch of conductor 108. The forward end of sheath 130 adjacent the open end of female connector 124 projects thereby and forms an inturned, annular lip portion 132. The internal diameter of the cover component 128 is sufficiently greater than the outside diameter of male connector 114 to permit the female connector 124 and the sheath 130 thereof to fit in the annular space thus provided. It should be noted that the outer end of component 128 projects beyond the outer end 116 of male connector 114 for a purpose to be discussed hereinafter.

An analogous arrangement exists with respect to the disconnect structure between clamp 102 and conductor 110, except that the male and female parts thereof are reversed as compared to the disconnect structure of FIG. 8 just described above. The terminal clamp 102 terminates in an outwardly projecting shank 134, the latter being of the same configuration as the shank 112 of clamp 100. However, it may be seen that a sheath 130c is slipped over shank 134, the outer end portion thereof being received within a cover component 128c which envelops the proximal end stretch of conductor 110. Thus, a female connector of the type shown at 124 in FIG. 8 is welded to the end of shank 134 in axial alignment therewith, the welded joint being formed at the interface provided by the end of shank 134 and the closed end of the female connector. Similarly, a male connector of the type shown at 114 in FIG. 8 has its inner end welded to the end of conductor 110 and fits within the female connector to complete the electrical coupling between clamp 102 and conductor 110. As illustrated in FIG. 8 with respect to the coupling structure between terminal clamp 100 and conductor 108, the cover component 128c projects beyond the outer end of the male connector therewith, and the outer end of the sheath 130c extends beyond the open end of the female connector therewith and forms an inturned, annular lip portion in the same manner as illustrated at 132 in FIG. 8. The extremities of the cover component 128 and the sheath 130 extend beyond the ends of the connectors to cause these connectors to become disengaged before disengagement of the cover component and sheath during removal of the male connector 114 from the female connector 124 to contain any are developing therebetween. An inturned, integral, annular lip or dent 135 on the outer end of cover component 128 is located to fit within an annular groove 137 in sheath 130 when the connectors are joined and serve as a latching structure which requires that a predetermined amount of force be applied to separate the connectors thus providing a degree of assurance that they will not be disconnected inadvertently by vibrations or the like.

Referring to the form of the invention shown in FIG. 9, a pair of disconnect units 136 and 136a are shown separated from the male and female connectors of the instant invention. The two units 136 and 136a are identical in construction, the only difference being in the illustrated orientation of the two units, shown with mating male and female connectors in alignment with one another.

The unit 136 includes a molded body of vinyl or similar material having a jacket portion 138 enveloping the end stretches of a pair of insulated, stranded conductors 140 and 142. A tubular female connector 144 is closed at its inner end, the latter being welded to the end of conductor 140. The conductor 140 is provided with a sleeve 146 crimped to the end thereof within jacket portion 138 and also a flanged end surface 148 projecting beyond the inner end of female connector 144. The details of the arrangement of the female connector 144 and conductor 140 are analogous to the female connector 124 and conductor 108 shown in detail in FIG. 8. A cover component 148 forms a part of the molded body of unit 136 and provides a sheath which extends in complemental, surrounding relationship to female connector 144 and projects beyond the end thereof in the same manner as shown and described previously for the sheaths of the female connectors of the other embodiments of the instant invention.

A cylindrical male connector 150 of the same type as shown at 114 in FIG. 8 and described above is disposed within a female connector 152 integral with jacket portion 138 and projecting somewhat beyond the outer end of male connector 150.

The identical disconnect unit 136c has its internal male and female connectors (not shown) flash butt welded to the ends of conductors 154 and 156, the male cover component of the molded body of unit 136c being shown at 158 in axial alignment with the female connector 144 and sheath 148 of unit 136. A sheath 160 surrounding the female connector of unit 136c is integral in axial alignment with the male connector 150 and cover component 152 of unit 136. It may be appreciated, therefore, that grasping of the two disconnect units 136 and 136a and movement of the same toward each other from the positions illustrated in FIG. 9 will cause the male and female connectors thereof to mate and effect relative telescoping of sheath 148 and component 158, and component 152 and sheath 160.

The male connectors of the various embodiments of the instant invention are all made from either square or cylindrical stock and are machined as needed to form the cylindrical pin portion thereof which is received by the mating female connector. In the case of male connectors of the type shown at 24 in FIGS. 5 and 6, square stock is utilized so that the square inner end section 44 remains after the machining operation. Similarly, the various female connectors are formed from cylindrical stock and are axially drilled to provide the necessary female opening. It may be appreciated, therefore that in both types of connectors a minimum of machining operations is required. Furthermore, the connectors are capable of accommodating different conductor sizes without modification.

Due to the monolithic character of both the male and female connectors of the instant invention, heavy currents can be readily handled thereby and the connectors are in-
herently durable. Referring to FIGS. 5 and 6, the semi-cylindrical contact elements 40 and 42 provided by the longitudinal slit 38 in the male connector 24 enable the male connector to be readily inserted into a mating female connector, the latter being sized to cause the elements 40 and 42 to flex inwardly to a degree to partially close slit 38. Thus, the mating male connector is held in position by friction augmented by the flexure of elements 40 and 42, thereby providing for quick insertion and removal of the male connector and yet assuring that the mating connectors will tend to remain in place once mated.

In utilizing the embodiment of FIGS. 1-4, it should be noted that all of the male connectors 24 and 26 in receptacle 10 and the female connectors 70 and 72 in plug 18 provides polarity protection by preventing inadvertent cross-connecting of the plug and receptacle. If it is attempted to insert plug 18 into receptacle 10 with female connector 70 aligned with male connector 26, contact will not be established between the shorter female connector 72 and the more recessed male connector 24 because of the inability of these two latter connectors to reach each other and make metal-to-metal contact.

In the form of the invention illustrated in FIGS. 7 and 8, polarity protection is provided in this embodiment by the arrangement of the cover components 128, 128a, and the female connector sheaths 130, 130a. All of the male cover components and female sheaths project beyond the ends of respective connectors so that, if it is attempted, for example, to connect female connector 124 with the female connector within sheath 130a, metal-to-metal contact will not be established between the two female connectors because of the projecting sheaths and their annular lips such as illustrated at 132 in FIG. 8. Similarly, an attempt to establish metal-to-metal contact between the male connector 114 and the male connector within cover component 128 will result in the open ends of cover component 128 and 128a to be brought into interengagement, the outer ends of the two male connectors remaining spaced apart.

The concept just set forth with respect to the embodiment of FIGS. 7 and 8 is also utilized in the form of the invention shown in FIG. 9. An attempt to join the two disconnect units 136 and 136a with male connectors facing each other and female connectors facing each other will only cause the cover components 152 and 158 and the sheaths 148 and 160 to abut one another with no metal-to-metal contact being produced. Thus, inadvertent connection is precluded. The disconnect units of FIG. 9 may be cascaded with other, like units to provide a 4-way connection or a greater number of connections if desired. Holes 162 provided through bosses 164 on the connectors are provided to receive fasteners such as bolts or the like to facilitate stacking or mounting of the connectors. The bosses 164 are of sufficient height to maintain adjacent sheaths out of contacting relationship when the units are joined together or fastened to a supporting surface. Disconnect units of this type are utilisable in a variety of applications where frequent changing of connections is to be encountered, such as in the charging of storage batteries for golf carts, small lift trucks, marine craft, and the like where the battery is charged at night and then connected to the motor of the vehicle during daytime use.

Although the connectors have been described as having a single conductor joined thereto, it is to be understood that a number of conductors of differing sizes may be joined to a single terminal unit and the terminals particularly lend themselves to joining of multiple conductors thereto because of their configuration and the way in which a number of wires may be easily clamped together with a single band and then flashed welded to the terminal. However, only a single terminal is required for all of the applications thus minimizing the parts inventory needed.

All of the embodiments of the instant invention possess moisture-resistant characteristics by virtue of the telescoping of the insulated coverings of the male and female connectors. This is perhaps best illustrated in FIGS. 4 and 8 where it may be seen that the sheaths 76, 78 and 130 are sandwiched between the female connectors therewithin and the cover components 30, 32 and 128 telescoped therewithin. Additionally, the use of O-rings 86 and 88 in the embodiment of FIGS. 1-4 assures that the plug 18 and receptacle 10 will be totally waterproof when joined. Thus, the mating connectors are protected from corrosion to provide a long useful life and assure that a low resistance electrical connection will be produced by the mating connectors.

Furthermore, by virtue of the use of a flexible plastic for plug housing 68, cover components 128, 128a, 130, and 130a, and the bodies of disconnect units 136 and 136a, alignment of the various male and female connectors on exact centers is not required. This obviates the need to maintain close manufacturing tolerances and also permits the male and female units to be readily mated and disconnected without excessive interference.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. High amperage, quick disconnect electrical coupling structure comprising:
   a pair of current-carrying members;
   a solid, monolithic, metallic male connector of elongated, cylindrical, metallic configuration having a longitudinally extending slit therein communicating with one end thereof and defining a pair of closely spaced, generally semi-cylindrical contact elements, the opposite end of said male connector being welded to one of said members; and
   a tubular, monolithic, metallic female connector welded to the other of said members and substantially complementarily receiving said male connector with said one end thereof disposed therewithin and said female connector being configured to cause flexure of said elements toward each other to partially close said slit as the male connector is inserted within the female connector,
   one of said connectors being provided with an integral end section having a plurality of flats facing in different directions, the member to which said one connector is welded being disposed in abutting relationship to one of said flats,
   said one connector being welded to the abutting member at said one flat.

2. Coupling structure as set forth in claim 1, there being first and second tubular, insulating cover components, said first component presenting a sheath extending over the female connector in complemental, surrounding relationship thereto, said second component being disposed in substantially coaxial, radially spaced, axially coextensive relationship to said male connector, and being telescoped over said sheath in closely fitting relationship thereto, at least one of said components being of flexible material to permit the connectors to be readily interconnected and separated without maintaining close manufacturing tolerances.

3. Coupling structure as set forth in claim 2, there being annular sealing means on said sheath sandwiched between the latter and said second component, whereby to render the coupling structure moistureproof.

4. Coupling structure as set forth in claim 2, each of said members comprising a flexible conductor having an end, each of said connectors being welded to the end of the corresponding conductor, each of said cover components being provided with a...
jacket portion enveloping a stretch of the corresponding conductor adjacent the end of the latter.

5. Electrical structure for coupling the high amperage beryllium of a piece of heavy vehicular equipment with an external source or load, said structure comprising:

a receptacle including a housing of insulating material having a pair of outwardly projecting tubular components disposed in substantial parallelism to each other, and a pair of solid, monolithic, metallic male connectors of elongated, cylindrical configuration axially disposed in corresponding components in longitudinally staggered relationship to each other and each having a longitudinally extending slit therein communicating with the outer end thereof and defining a pair of closely spaced, generally semicylindrical contact elements;

means for securing said receptacle to said piece of equipment;

a first pair of current-carrying conductors adapted for connection to opposite polarity terminals of said battery, extending into said receptacle housing and terminating therein adjacent respective male connectors, the opposite end of each male connector being welded to the corresponding conductor;

a plug including a pair of tubular, monolithic, metallic female connectors disposed in longitudinally staggered relationship to each other and substantially complementarily receiving corresponding male connectors with the outer ends thereof disposed therewithin, and a housing of insulating material for said female connectors having a pair of outwardly projecting, tubular sheaths extending over respective female connectors in complemental, surrounding relationship thereto, each of said female connectors being configured to cause flexure of the elements of the male connector therewithin toward each other to partially close the slit as the plug is inserted into the receptacle, each of said components being radially spaced from the corresponding male connector to telescope over the sheath therewithin in closely fitting relationship thereto; and

a second pair of current-carrying conductors adapted to be coupled with opposite polarity terminals of said external source or load, extending into said plug housing and terminating therein adjacent respective female connectors, each female connector being welded to the corresponding conductor of said second pair, said receptacle housing being of structurally strong, rigid, synthetic resin material to thereby permit direct mounting on said piece of equipment, said plug housing being of flexible, synthetic resin material to permit the plug to be readily inserted into and removed from the receptacle without maintaining close manufacturing tolerances.

6. Electrical structure as set forth in claim 5, each of said housings having a jacket portion enveloping respective stretches of the conductors therewithin adjacent the welds, there being annular sealing means on each of said sheaths sandwiched between the latter and the component telescoped thereover, whereby to render the structure moistureproof.

7. Electrical structure as set forth in claim 5, said components being axially staggered and terminat-