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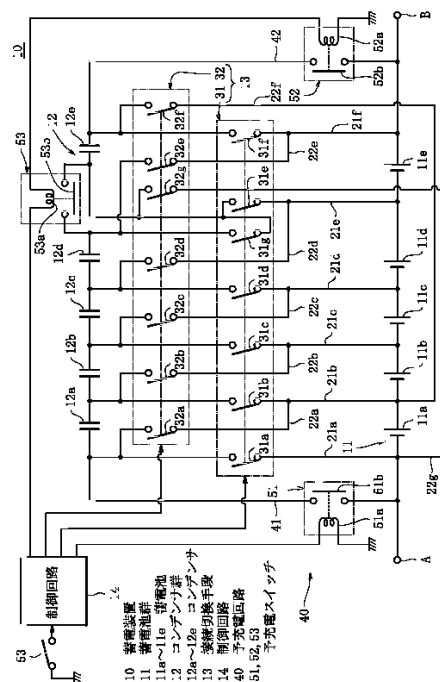
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(54)【発明の名称】 蓄電装置

(57)【要約】

【課題】突入電流による接続切手段の損傷を防止し、小型化を可能とする。

【解決手段】蓄電池群11及びコンデンサ群12はそれぞれ直列接続された複数の蓄電池11a~11e及びコンデンサ12a~12eからなる。接続切手段13は各コンデンサをこの各コンデンサに対応する各蓄電池又は各蓄電池の隣の蓄電池に並列接続させる第1又は第2接続モードと、各コンデンサを各蓄電池のいずれとも電氣的に遮断する非接続モードとを選択的に切換え、制御回路14は第1及び第2接続モードの切換えを繰返し行うように接続切手段を制御する。予充電回路40は蓄電池群とコンデンサ群とにより閉回路を構成し、蓄電池群とコンデンサ群を電氣的に接続又は遮断する予充電スイッチ51,52,53を有する。電源投入時であって非接続モード切換え時に、制御回路は予充電回路を制御して、蓄電池群とコンデンサ群を電氣的に接続する。



【特許請求の範囲】

【請求項1】 互いに直列接続された複数の蓄電池(11a～11e)からなる蓄電池群(11)と；互いに直列接続された複数のコンデンサ(12a～12e)からなるコンデンサ群(12)と；前記各コンデンサ(12a～12e)をこの各コンデンサに対応する各蓄電池(11a～11e)にそれぞれ並列接続させる第1接続モードと、前記各コンデンサ(12a～12e)をこの各コンデンサに対応する各蓄電池(11a～11e)の隣の蓄電池(11b～11e, 11a)にそれぞれ並列接続させる第2接続モードと、前記各コンデンサ(12a～12e)を前記各蓄電池(11a～11e)のいずれとも電気的に遮断する非接続モードとに選択的に切換える接続切換手段(13)と；前記第1及び第2接続モードの切換えを繰返し行うように前記接続切換手段(13)を制御する制御回路(14)とを備えた蓄電装置であって；前記蓄電池群(11)と前記コンデンサ群(12)とにより閉回路を構成しかつ前記蓄電池群(11)と前記コンデンサ群(12)を電気的に接続又は遮断する予充電スイッチ(51, 52, 53)を有する予充電回路(40)を更に備え；電源投入時であって前記接続切換手段(13)による非接続モード切換え時に、前記制御回路(14)が前記予充電回路(40)を制御して前記蓄電池群(11)と前記コンデンサ群(12)を電気的に接続するように構成されたことを特徴とする蓄電装置。

【請求項2】 制御回路(14)は閉回路を構成した状態の予充電回路(40)を制御して蓄電池群(11)とコンデンサ群(12)を電気的に遮断した後に、接続切換手段(13)を制御して第1又は第2接続モードに切換えるように構成された請求項1記載の蓄電装置。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、電気自動車に搭載されるバッテリーに適する蓄電装置に関するものである。

【0002】

【従来の技術】従来、この種の蓄電装置として、蓄電池群が互いに直列接続された複数の蓄電池からなり、コンデンサ群が互いに直列接続された複数のコンデンサからなり、接続切換手段が第1及び第2接続モードを選択的に切換え可能に構成され、制御回路が第1及び第2接続モードの切換えを繰返し行うように接続切換手段を制御するように構成された蓄電装置が開示されている（特開平10-164768号公報）。この蓄電装置では、第1接続モードが各コンデンサをこの各コンデンサに対応する各蓄電池にそれぞれ並列接続させるモードであり、第2接続モードが各コンデンサをこの各コンデンサに対応する各蓄電池の隣の蓄電池にそれぞれ並列接続させるモードである。また接続切換手段としてはスイッチングロスの小さいFET（電界効果トランジスタ）、IGBT（絶縁ゲートトランジスタ）等の電力用半導体リレーが用いられる。このように構成された蓄電装置では、複数の蓄電池の間に電荷を移送できるようになり、電圧均

衡化に際してのアンバランス電圧分を、放電抵抗器での放熱により浪費させることなく、低電圧の蓄電池の電圧上昇に利用できるようになる。この結果、蓄電装置の電力損失を低減することができるとともに、放熱対策が不要になる。

【0003】

【発明が解決しようとする課題】しかし、上記従来の特開平10-164768号に記載された蓄電装置では、この装置の始動時における大きな突入電流により電力用半導体リレー（接続切換手段）が損傷するおそれがある。この損傷はコンデンサが未充電である場合や、漏れ電流によりコンデンサが放電状態である場合に、蓄電装置を作動させると発生するおそれがある。このため、上記突入電流に耐え得る大きな電流容量を有する半導体リレーを選択して使用する必要がある。しかし、大きな電流容量を有する半導体リレーは高価でかつ形状が大きいため、製造コストの増大や装置の大型化を招く問題点があった。本発明の目的は、突入電流による接続切換手段の損傷を防止し、小型化が可能であり、かつ製造コストを低減できる蓄電装置を提供することにある。

【0004】

【課題を解決するための手段】請求項1に係る発明は、図1に示すように、互いに直列接続された複数の蓄電池11a～11eからなる蓄電池群11と；互いに直列接続された複数のコンデンサ12a～12eからなるコンデンサ群12と；各コンデンサ12a～12eをこの各コンデンサに対応する各蓄電池11a～11eにそれぞれ並列接続させる第1接続モードと、各コンデンサ12a～12eをこの各コンデンサに対応する各蓄電池11a～11eの隣の蓄電池11b～11e, 11aにそれぞれ並列接続させる第2接続モードと、各コンデンサ12a～12eを各蓄電池11a～11eのいずれとも電気的に遮断する非接続モードとに選択的に切換える接続切換手段13と；第1及び第2接続モードの切換えを繰返し行うように接続切換手段13を制御する制御回路14とを備えた蓄電装置であって；蓄電池群11とコンデンサ群12とにより閉回路を構成しかつ蓄電池群11とコンデンサ群12を電気的に接続又は遮断する予充電スイッチ51, 52, 53を有する予充電回路40を更に備え；電源投入時であって接続切換手段13による非接続モード切換え時に、制御回路14が予充電回路40を制御して蓄電池群11とコンデンサ群12を電気的に接続するように構成されたことを特徴とする。

【0005】この請求項1に記載された蓄電装置では、電源を投入すると、制御回路14は非接続モードに保った状態で予充電スイッチ51, 52, 53を閉じる。これにより蓄電池群11とコンデンサ群12が電気的に接続されて予充電回路40が閉回路となるため、各コンデンサ12a～12eに電荷が略均等に充填され、各蓄電池11a～11eと各コンデンサ12a～12eの電位

差が極めて小さくなる。

【0006】請求項2に係る発明は、請求項1に係る発明であって、更に図1に示すように、制御回路14が閉回路を構成した状態の予充電回路40を制御して蓄電池群11とコンデンサ群12を電氣的に遮断した後に、接続切換手段13を制御して第1又は第2接続モードに切換えるように構成されたことを特徴とする。この請求項2に記載された蓄電装置では、電源を投入すると、制御回路14は非接続モードに保った状態で予充填スイッチ51, 52, 53を閉じる。これにより蓄電池群11とコンデンサ群12が電氣的に接続されて予充電回路40が閉回路となるため、各コンデンサ12a～12eに電荷が略均等に充填され、各蓄電池11a～11eと各コンデンサ12a～12eの電位差が極めて小さくなる。この状態で制御回路14は予充電スイッチ40を開いた後に、第1及び第2接続モードの切換えを繰返し行う。このように蓄電池11a～11eとコンデンサ12a～12eとの電位差が極めて小さくなった後に、第1及び第2接続モードの切換え動作が行われるため、突入電流は極めて小さくなる。

【0007】

【発明の実施の形態】次に本発明の実施の形態を図面に基いて説明する。図1に示すように、電気自動車に搭載される蓄電装置10は互いに直列接続された複数の蓄電池11a～11eからなる蓄電池群11と、互いに直列接続された複数のコンデンサ12a～12eからなるコンデンサ群12と、第1接続モード、第2接続モード及び非接続モードに選択的に切換える接続切換手段13と、第1及び第2接続モードの切換えを繰返し行うように接続切換手段13を制御する制御回路14とを備える。この実施の形態では蓄電池群11は5個の第1～第5蓄電池11a～11eからなり、コンデンサ群12は5個の第1～第5コンデンサ12a～12eからなる。第1～第5コンデンサ12a～12eは第1～第5蓄電池11a～11eにそれぞれ対応するように配設され、蓄電池群11の両端A, Bにはモータ等が接続される。なお、蓄電池群は6個以上の蓄電池により構成してもよく、コンデンサ群は6個以上のコンデンサにより構成してもよい。また蓄電装置は電気自動車ではなく、潜水艇等の多数のバッテリーからなる組電池を使用する場合にも適用できる。

【0008】第1～第5コンデンサ12a～12eは第1～第6対応用接続線21a～21fにより第1～第5蓄電池11a～11eにそれぞれ並列接続される。第1～第6対応用接続線21a～21fには第1～第6対応用スイッチ31a～31fが設けられ、第4コンデンサ12dと第5対応用接続線21eの上端との間には第7対応用スイッチ31gが設けられる。また第1対応用スイッチ31aの上側端子は第1隣接用接続線22aにより第2対応用スイッチ31bの下側端子に接続され、第2

対応用スイッチ31bの上側端子は第2隣接用接続線22bにより第3対応用スイッチ31cの下側端子に接続される。第3対応用スイッチ31cの上側端子は第3隣接用接続線22cにより第4対応用スイッチ31dの下側端子に接続され、第4対応用スイッチ31dの上側端子は第4隣接用接続線22dにより第5対応用スイッチ31eの下側端子に接続される。第7対応用スイッチ31gの上側端子は第5隣接用接続線22eにより第6対応用スイッチ31fの下側端子に接続され、第6対応用スイッチ31fの上側端子は第6隣接用接続線22fにより第2対応用スイッチ31bの下側端子に接続される。第1～第6隣接用接続線22a～22fには第1～第6隣接用スイッチ32a～32fがそれぞれ設けられる。また符号22gは第5対応用スイッチ31eの上側端子と第1対応用スイッチ31aの下側端子とを接続する補助接続線であり、この補助接続線22gには第7隣接用スイッチ32gが設けられる。

【0009】上記第1～第7対応用スイッチ31a～31gにより第1切換スイッチ群31が構成され、上記第1～第7隣接用スイッチ32a～32gにより第2切換スイッチ群32が構成される。また第1切換スイッチ群31と第2切換スイッチ群32とにより上記接続切換手段13が構成される。第1～第7対応用スイッチ31a～31gは連動して同時にオンオフし、第1～第7隣接用スイッチ32a～32gは連動して同時にオンオフするように構成される。これらのスイッチ31a～31g, 32a～32gは電流量の小さい半導体リレー（電流量：50mA～2A）、例えば電流量が2Aのフォトモススイッチにより構成されることが好ましい。上記スイッチ31a～31g, 32a～32gをフォトモススイッチにより構成した場合、これらのスイッチのオンオフ動作は発光ダイオード（図示せず）の点滅により行われる。即ち、上記発光ダイオードは制御回路14の制御出力に接続され、制御回路14が所定の周波数で発光ダイオードを点滅させることにより上記スイッチ31a～31g, 32a～32gがオンオフするように構成される。

【0010】第1接続モードとは、第1～第7対応用スイッチ31a～31gが閉じかつ第1～第7隣接用スイッチ32a～32gが開いて、第1～第5コンデンサ12a～12eをこれらのコンデンサに対応する第1～第5蓄電池11a～11eにそれぞれ並列接続させるモードである。また第2接続モードとは、第1～第7隣接用スイッチ32a～32gが閉じかつ第1～第7対応用スイッチ31a～31gが開いて、第1～第5コンデンサ12a～12eをこれらのコンデンサに対応する第1～第5蓄電池11a～11eの隣の第2～第5及び第1蓄電池11b～11e, 11aにそれぞれ並列接続させるモードである。更に非接続モードとは、第1～第7対応用スイッチ31a～31g及び第1～第7隣接用スイッ

チ32a～32gが全て開いて、各コンデンサ12a～12eを各蓄電池11a～11eのいずれとも電氣的に遮断するモードである。なお、この実施の形態では、第2接続モードにおいて第5蓄電池11eの隣の蓄電池を第1蓄電池11aとし、第5コンデンサ12eと第1蓄電池11aとが並列接続される。また、第1～第7対応用スイッチ及び第1～第7隣接用スイッチを電流量が20mA～1AのFETやIGBT等により構成してもよい。

【0011】一方、蓄電装置10には蓄電池群11とコンデンサ群12とにより閉回路を構成する予充電回路40が設けられる。この予充電回路40は第1コンデンサ12aの一端と第1蓄電池11aの一端とを接続する第1予充電接続線41と、第5コンデンサ12eの他端と第5蓄電池11eの他端とを接続する第2予充電接続線42と、第1予充電接続線41に設けられた第1予充電スイッチ51と、第2予充電接続線42に設けられた第2及び第3予充電スイッチ52、53とを有する。この実施の形態では第1～第3予充電スイッチ51～53は電流量の大きな接点式リレー（電流量：6～20A）である。第1予充電スイッチ51は第1コイル部51aと、このコイル部51aに電流が流れると閉じる第1スイッチ部51bとからなり、第2予充電スイッチ52は第2コイル部52aと、このコイル部52aに電流が流れると閉じる第2スイッチ部52bとからなり、第3予充電スイッチ53は第3コイル部53aと、このコイル部53aに電流が流れると閉じる第3スイッチ部53bとからなる。第1～第3コイル部51a～53aは制御回路14の制御出力に接続され、第1及び第2スイッチ部51b、52bは第1及び第2予充電接続線41、42にそれぞれ接続され、第3スイッチ部53bは第7対応用スイッチ31gと並列に接続される。

【0012】更に制御回路14の制御入力にはキースイッチ54が接続され、制御回路14には予充電スイッチ51～53を閉じている時間を出力するタイマ（図示せず）と、発光ダイオードを所定の周波数で点滅させる発振回路（図示せず）が設けられる。なお、予充電スイッチとしては接点式リレーではなく、電流量の大きな半導体リレー（電流量が6～10AであるフォトモススイッチやIGBT等）を用いてもよい。

【0013】このように構成された蓄電装置10の動作を説明する。電気自動車のキースイッチ54をオンすると、制御回路14は第1～第3予充電スイッチ51～53の第1～第3コイル部51a～53aに電流を流して第1～第3スイッチ部51b～53bを閉じる。このとき制御回路14は発光ダイオードを消灯状態（非接続モード）に保つ。第1～第3スイッチ部51b～53bが閉じると、蓄電池群11とコンデンサ群12が電氣的に接続されて予充電回路40が閉回路となるため、電荷を蓄えていない（放電した）各コンデンサ12a～12e

に各蓄電池11a～11eから電荷が略均等に充填され、各蓄電池11a～11eと各コンデンサ12a～12eの電位差が極めて小さくなる。なお、第1～第3スイッチ部51b～53bを閉じたときに比較的大きな突入電流が各コンデンサ12a～12eに流れるけれども、第1～第3予充電スイッチ51～53は電流量が大きいので損傷することはない。

【0014】次に制御回路14はタイマからの信号により所定時間が経過したと判断すると、第1～第3コイル部51a～53aへの通電を停止し、第1～第3スイッチ部51b～53bを開く。このとき上記各コンデンサ12a～12eは電荷が略均等に充填された状態に保たれる。この状態で制御回路14は発振回路を作動させて発光ダイオードを所定の周波数で点滅させ、第1及び第2接続モードの切換えを繰返し行い、各蓄電池11a～11eの電圧を均衡化する。このように蓄電池11a～11eとコンデンサ12a～12eとの電位差が極めて小さくなった後に、第1及び第2接続モードの切換え動作が行われるため、突入電流は極めて小さくなる。この結果、電流量の小さい第1～第7対応用スイッチ31a～31g及び第1～第7隣接用スイッチ32a～32gを用いても、これらのスイッチ31a～31g、32a～32gが突入電流により損傷することはない。また上述のように制御回路14が予充電回路40を制御した後に接続切換手段13を制御するという2段階制御を行うことにより、電源投入時の接続切換手段13の誤動作を防ぐことができる。

【0015】

【発明の効果】以上述べたように、本発明によれば、予充電回路が蓄電池群とコンデンサ群とともに閉回路を構成し、かつ蓄電池群とコンデンサ群を電氣的に接続又は遮断する予充電スイッチを有し、電源投入時であって接続切換手段による非接続モード切換え時に、制御回路が予充電回路を制御して蓄電池群とコンデンサ群を電氣的に接続するので、各コンデンサに電荷が略均等に充填され、各蓄電池と各コンデンサの電位差が極めて小さくなる。また制御回路が閉回路を構成した状態の予充電回路を制御して蓄電池群とコンデンサ群を電氣的に遮断した後に、接続切換手段を制御して第1又は第2接続モードに切換えるように構成すれば、蓄電池とコンデンサとの電位差が極めて小さくなった後に、第1及び第2接続モードの切換え動作が行われるため、第1又は第2接続モードへの切換え時における突入電流を小さくすることができる。この結果、接続切換手段として電流量が小さくかつ小型で安価な半導体リレーを用いても損傷することなく、更に蓄電装置の小型化及び製造コストの低減を図ることができる。

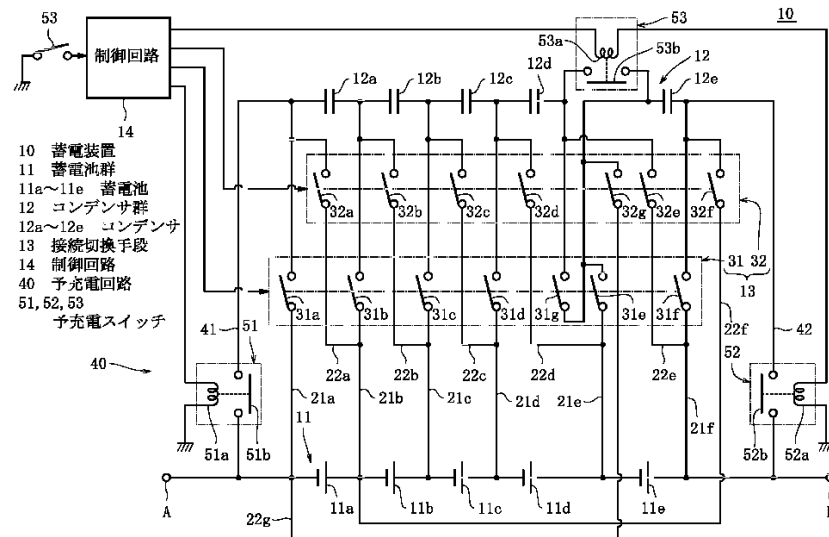
【図面の簡単な説明】

【図1】本発明実施形態の蓄電装置の回路構成図。

【符号の説明】

- | | |
|---------------|--------------------|
| 10 蓄電装置 | 13 接続切換手段 |
| 11 蓄電池群 | 14 制御回路 |
| 11a~11e 蓄電池 | 40 予充電回路 |
| 12 コンデンサ群 | 51, 52, 53 予充電スイッチ |
| 12a~12e コンデンサ | |

【図1】



フロントページの続き

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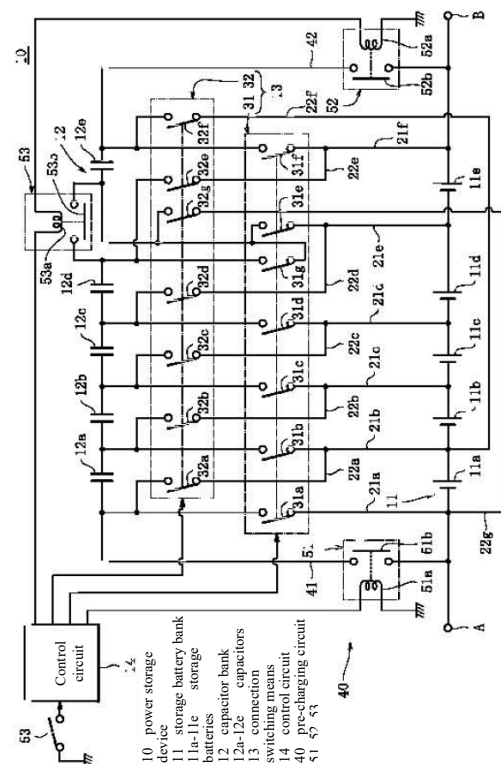
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(54) [Title of the Invention] Power storage device

(57) [Abstract]

[Problem] To prevent damage to the connection switching means caused by inrush current and to enable miniaturization. [Means for Solving] The storage battery bank 11 and the capacitor bank 12 each consist of multiple storage batteries 11a-11e and capacitors 12a-12e connected in series. The connection switching means 13 selectively switches between a first or second connection mode in which each capacitor is connected in parallel to its corresponding storage battery or the storage battery adjacent to it, and a non-connection mode in which each capacitor is electrically isolated from all of the storage batteries. The control circuit 14 controls the connection switching means to repeatedly switch between the first and second connection modes. The pre-charging circuit 40 forms a closed circuit with the storage battery bank and the capacitor bank, and includes pre-charging switches 51, 52, and 53 that electrically connect or isolate the storage battery bank and the capacitor bank. When the power is turned on and the non-connection mode is switched, the control circuit controls the pre-charging circuit to electrically connect the storage battery bank and the capacitor bank.



[Scope of Patent Claims]

[Claim 1] A power storage device comprising: a storage battery bank (11) consisting of a plurality of storage batteries (11a-11e) connected in series with each other; a capacitor bank (12) consisting of a plurality of capacitors (12a-12e) connected in series with each other; a connection switching means (13) for selectively switching between a first connection mode in which each capacitor (12a-12e) is connected in parallel with its corresponding storage battery (11a-11e), a second connection mode in which each capacitor (12a-12e) is connected in parallel with the storage battery adjacent to its corresponding storage battery (11b-11e, 11a), and a non-connection mode in which each capacitor (12a-12e) is electrically disconnected from each storage battery (11a-11e); a control circuit (14) for controlling the connection switching means (13) to repeatedly switch between the first and second connection modes; and further comprising a pre-charging circuit (40) having pre-charging switches (51, 52, 53) that constitutes a closed circuit with the storage battery bank (11) and the capacitor bank (12) and electrically connects or disconnects the storage battery bank (11) and the capacitor bank (12), wherein when the power is turned on and the connection switching means (13) switches to the non-connection mode, the control circuit (14) controls the pre-charging circuit (40) to electrically connect the storage battery bank (11) and the capacitor bank (12).

[Claim 2:] The power storage device according to Claim 1, wherein the control circuit (14) is configured to control the pre-charging circuit (40) in a closed-circuit state, then electrically disconnect the storage battery bank (11) and the capacitor bank (12), and then control the connection switching means (13) to switch to the first or second connection mode.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention] The present invention relates to a power storage device suitable for storage batteries installed in electric vehicles.

[0002]

[Prior Art] Conventionally, this type of power storage device has been disclosed as comprising a storage battery bank consisting of multiple storage batteries connected in series with each other, a capacitor bank consisting of multiple capacitors connected in series with each other, a connection switching means capable of selectively switching between a first and second connection mode, and a control circuit configured to repeatedly switch between the first and second connection modes by controlling the connection switching means (Unexamined patent application 10-164768). In this power storage device, the first connection mode is a mode in which each capacitor is connected in parallel with the corresponding storage battery, and the second connection mode is a mode in which each capacitor is connected in parallel with the storage battery adjacent to the corresponding storage battery. Power semiconductor relays such as FETs (field-effect transistors) and IGBTs (insulated gate bipolar transistors), which have low switching losses, are used as the connection switching means. In the power storage device configured in this way, it becomes possible to transfer charge between multiple storage batteries, and the unbalanced voltage during voltage equalization can be utilized to increase the voltage of low-voltage storage batteries

without waste through heat through discharge resistors. As a result, the power loss of the power storage device can be reduced, and heat dissipation measures are unnecessary.

[0003]

[Problem to be Solved by the Invention] However, in the power storage device described in the above-mentioned prior art (Japanese Unexamined Patent Application Publication H10-164768), there is a risk that the power semiconductor relay (connection switching means) may be damaged due to the large inrush current at the starting of the device. This damage can occur when the power storage device is activated when the capacitor is uncharged or when the capacitor is discharged due to leakage current. Therefore, it is necessary to select and use a semiconductor relay with a large current capacity that can withstand the above inrush current. However, semiconductor relays with large current capacity are expensive and have a large size, which leads to increased manufacturing costs and larger equipment size. The object of the present invention is to provide a power storage device that can prevent damage to the connection switching means due to inrush current, can be miniaturized, and can reduce manufacturing costs.

[0004]

[Means for Solving the Problem] As presented in Figure 1, the power storage device according to the invention in Claim 1 is characterized by comprising a storage battery bank 11 consisting of a plurality of storage batteries 11a to 11e connected in series with each other; a capacitor bank 12 consisting of a plurality of capacitors 12a to 12e connected in series with each other; a connection switching means 13 selectively switching between a first connection mode in which each capacitor 12a to 12e is connected in parallel with the corresponding storage battery 11a to 11e; a second connection mode in which each capacitor 12a to 12e is connected in parallel with the storage battery 11b to 11e, 11a adjacent to the corresponding capacitor; and a non-connection mode in which each capacitor 12a to 12e is electrically disconnected from any of the storage batteries 11a to 11e; and a control circuit 14 controlling the connection switching means 13 to repeatedly switch between the first and second connection modes; and further comprising a pre-charging circuit 40 which constitutes a closed circuit with the storage battery bank 11 and the capacitor bank 12 and has pre-charging switches 51, 52, 53 for electrically connecting or disconnecting the storage battery bank 11 and the capacitor bank 12; and is characterized in that, when the power is turned on and the non-connection mode is switched by the connection switching means 13, the control circuit 14 controls the pre-charging circuit 40 to electrically connect the storage battery bank 11 and the capacitor bank 12.

[0005] In the power storage device described in Claim 1, when the power supply is turned on, the control circuit 14 closes the pre-charging switches 51, 52, and 53 while maintaining a non-connected mode. As a result, the storage battery bank 11 and the capacitor bank 12 are electrically connected, and the pre-charging circuit 40 thereby becomes a closed circuit, so that the charge is filled approximately equally to each capacitor 12a to 12e, and the potential difference between each storage battery 11a to 11e and each capacitor 12a to 12e becomes extremely small.

[0006] The invention according to Claim 2 is an invention according to Claim 1, further characterized in that, as shown in Figure 1, the control circuit 14 is configured to control the pre-charging circuit 40 in a state constituting a closed circuit, electrically disconnect the storage battery bank 11 and the capacitor bank 12, and then control the connection switching means 13 to switch to the first or second connection mode. In the power storage device described in Claim 2, when the power supply is turned on, the control circuit 14 closes the pre-charging switches 51, 52, and 53 while maintaining a non-connected mode. As a result, the storage battery bank 11 and the capacitor bank 12 are electrically connected, and the pre-charging circuit 40 thereby becomes a closed circuit, so that the charge is filled approximately equally to each capacitor 12a to 12e, and the potential difference between each storage battery 11a to 11e and each capacitor 12a to 12e becomes extremely small. In this state, the control circuit 14 repeatedly switches between the first and second connection modes after opening the pre-charging switch 40. Since the switching between the first and second connection modes is performed after the potential difference between the storage batteries 11a-11e and capacitors 12a-12e has become extremely small in this way, the inrush current becomes extremely small.

[0007]

[Examples of Embodiment] The following describes the embodiments of the present invention based on the drawings. As shown in Figure 1, the power storage device 10 mounted on an electric vehicle includes a storage battery bank 11 consisting of a plurality of storage batteries 11a-11e connected in series, a capacitor bank 12 consisting of a plurality of capacitors 12a-12e connected in series, a connection switching means 13 selectively switchable to a first connection mode, a second connection mode, and a non-connection mode, and a control circuit 14 that controls the connection switching means 13 to repeatedly switch between the first and second connection modes. In this embodiment, the storage battery bank 11 consists of the first to fifth storage batteries 11a to 11e, and the capacitor bank 12 consists of the first to fifth capacitors 12a to 12e. The first to fifth capacitors 12a to 12e are arranged to correspond to the first to fifth storage batteries 11a to 11e, respectively, and motors or the like are connected to the terminals A and B of the storage battery bank 11. Note that the storage battery bank may be configured with more than six storage batteries, and the capacitor bank may be configured with more than six capacitors. Furthermore, the power storage device can be applied not only to electric vehicles but also to storage battery banks consisting of multiple storage batteries, such as in submarines.

[0008] The first to fifth capacitors 12a to 12e are connected in parallel to the first to fifth storage batteries 11a to 11e, respectively, via first to sixth corresponding connection lines 21a to 21f. First to sixth corresponding switches 31a to 31f are provided on the first to sixth corresponding connection lines 21a to 21f, and a seventh corresponding switch 31g is provided between the fourth capacitor 12d and the upper end of the fifth corresponding connection line 21e. The upper terminal of the first corresponding switch 31a is also connected to the lower terminal of the second corresponding switch 31b via the first

adjacent connection line 22a, and the upper terminal of the second corresponding switch 31b is connected to the lower terminal of the third corresponding switch 31c via the second adjacent connection line 22b. The upper terminal of the third corresponding switch 31c is connected to the lower terminal of the fourth corresponding switch 31d via the third adjacent connection line 22c, and the upper terminal of the fourth corresponding switch 31d is connected to the lower terminal of the fifth corresponding switch 31e via the fourth adjacent connection line 22d. The upper terminal of the seventh corresponding switch 31g is connected to the lower terminal of the sixth corresponding switch 31f via the fifth adjacent connection line 22e, and the upper terminal of the sixth corresponding switch 31f is connected to the lower terminal of the second corresponding switch 31b via the sixth adjacent connection line 22f. The first to sixth adjacent connection lines 22a to 22f each have a corresponding first to sixth adjacent switch 32a to 32f. In addition, the reference numeral 22g represents an auxiliary connection line that connects the upper terminal of the fifth corresponding switch 31e to the lower terminal of the first corresponding switch 31a, and the seventh adjacent switch 32g is provided on this auxiliary connection line 22g.

[0009] The first bank of switching switches 31 is formed by the first to seventh corresponding switches 31a to 31g, and the second bank of switching switches 32 is formed by the first to seventh adjacent switches 32a to 32g. The connection switching means 13 is also formed by the first bank of switching switches 31 and the second bank of switching switches 32. The first to seventh corresponding switches 31a to 31g are configured to turn on and off simultaneously in coordination, and the first to seventh adjacent switches 32a to 32g are configured to turn on and off simultaneously in coordination. It is preferable that these switches 31a to 31g, 32a to 32g are formed by semiconductor relays with a small current capacity (current capacity: 50mA to 2A), for example, PhotoMOS switches with a current capacity of 2A. When the switches 31a to 31g, 32a to 32g are formed by PhotoMOS switches, the on and off operations of these switches are performed by the flashing of a light-emitting diode (not shown). That is, the light-emitting diode is connected to the control output of the control circuit 14, and the control circuit 14 is configured to flash the light-emitting diode at a predetermined frequency to turn the switches 31a to 31g, 32a to 32g on and off.

[0010] The first connection mode is a mode where the first to seventh corresponding switches 31a to 31g are closed and the first to seventh adjacent switches 32a to 32g are open, thereby connecting the first to fifth capacitors 12a to 12e in parallel with the first to fifth storage batteries 11a to 11e corresponding to these capacitors, respectively. The second connection mode is a mode where the first to seventh adjacent switches 32a to 32g are closed and the first to seventh corresponding switches 31a to 31g are open, thereby connecting the first to fifth capacitors 12a to 12e in parallel with the second to fifth and first storage batteries 11b to 11e adjacent to the first to fifth storage batteries 11a to 11e corresponding to these capacitors, respectively. The non-connection mode is a mode where all the first to seventh corresponding switches 31a to 31g and the first to seventh

adjacent switches 32a to 32g are open, thereby electrically isolating each capacitor 12a to 12e from each storage battery 11a to 11e. In this embodiment, in the second connection mode, the storage battery adjacent to the fifth storage battery 11e is set as the first storage battery 11a, and the fifth capacitor 12e and the first storage battery 11a are connected in parallel. Additionally, the first to seventh corresponding switches and the first to seventh adjacent switches can be configured using FETs or IGBTs with a current capacity of 20 mA to 1 A.

[0011] On the other hand, the power storage device 10 is equipped with a pre-charging circuit 40 that forms a closed circuit with a storage battery bank 11 and a capacitor bank 12. This pre-charging circuit 40 includes a first pre-charging connection line 41 that connects one end of the first capacitor 12a to one end of the first storage battery 11a, a second pre-charging connection line 42 that connects the other end of the fifth capacitor 12e to the other end of the fifth storage battery 11e, a first pre-charging switch 51 provided on the first pre-charging connection line 41, and second and third pre-charging switches 52 and 53 provided on the second pre-charging connection line 42. In this embodiment, the first to third pre-charging switches 51 to 53 are contact type relays with a large current capacity (current capacity: 6-20A). The first pre-charging switch 51 consists of a first coil section 51a and a first switch section 51b that closes when current flows through the coil section 51a. The second pre-charging switch 52 consists of a second coil section 52a and a second switch section 52b that closes when current flows through the coil section 52a. The third pre-charging switch 53 consists of a third coil section 53a and a third switch section 53b that closes when current flows through the coil section 53a. The first to third coil sections 51a to 53a are connected to the control output of the control circuit 14, the first and second switch sections 51b, 52b are connected to the first and second pre-charging connection lines 41, 42, respectively, and the third switch section 53b is connected in parallel with the seventh corresponding switch 31g.

[0012] Furthermore, the key switch 54 is connected to the control input of the control circuit 14, and a timer (not shown) that outputs the time the pre-charging switches 51 to 53 are closed and an oscillator circuit (not shown) that flashes an LED at a predetermined frequency are provided in the control circuit 14. Note that instead of a contact type relay, a semiconductor relay with a large current capacity (such as a PhotoMOS switch or IGBT with a current capacity of 6 to 10 A) can be used as the pre-charging switch.

[0013] The operation of the power storage device 10, which is thus configured, will now be described. When the key switch 54 of an electric vehicle is turned on, the control circuit 14 flows current to the first to third coil sections 51a to 53a of the first to third pre-charging switches 51 to 53, thereby closing the first to third switch sections 51b to 53b. At this time, the control circuit 14 keeps the LED in an off state (non-connected mode). When the first to third switch sections 51b to 53b are closed, the storage battery bank 11 and the capacitor pack 12 are electrically connected, and the pre-charging circuit 40 becomes a closed circuit. As a result, the capacitors 12a to 12e, which are not charged (discharged), are charged almost equally from each storage battery 11a to 11e, and the potential difference

between each storage battery 11a to 11e and each capacitor 12a to 12e becomes very small. Although a relatively large inrush current flows into each capacitor 12a to 12e when the first to third switch sections 51b to 53b are closed, the first to third pre-charging switches 51 to 53 do not get damaged because they have a large current capacity.

[0014] Next, when the control circuit 14 determines that a predetermined time has elapsed based on a signal from the timer, it stops supplying power to the first to third coil sections 51a to 53a and opens the first to third switch sections 51b to 53b. At this time, the capacitors 12a to 12e are kept in a state where they are charged almost equally. In this state, the control circuit 14 activates the oscillator circuit to make the light-emitting diode blink at a predetermined frequency, repeatedly switching between the first and second connection modes, and equalizing the voltage of each storage battery 11a to 11e. Since the switching between the first and second connection modes is performed after the potential difference between the storage batteries 11a-11e and capacitors 12a-12e has become extremely small in this way, the inrush current becomes extremely small. As a result, even when using the first to seventh corresponding switches 31a to 31g and the first to seventh adjacent switches 32a to 32g, which have a small current capacity, these switches 31a to 31g, 32a to 32g will not be damaged by the inrush current. Furthermore, by performing a two-step control in which the control circuit 14 controls the pre-charging circuit 40 and then controls the connection switching means 13, as described above, it is possible to prevent malfunction of the connection switching means 13 at the time of power-on.

[0015]

[Effect of the invention] As described above, according to the present invention, the pre-charging circuit forms a closed circuit with the storage battery bank and the capacitor bank, and has a pre-charging switch that electrically connects or disconnects the storage battery bank and the capacitor bank. When the power is turned on and the connection switching means switches to the non-connection mode, the control circuit controls the pre-charging circuit to electrically connect the storage battery bank and the capacitor bank, so that the charge is filled almost equally in each capacitor, and the potential difference between each storage battery and each capacitor becomes extremely small. If the pre-charging circuit, in which the control circuit forms a closed circuit, is controlled to electrically disconnect the storage battery bank and the capacitor bank, and then the connection switching means is controlled to switch to the first or second connection mode, the inrush current at the time of switching to the first or second connection mode can be reduced because the switching operation between the first and second connection modes is performed after the potential difference between the storage battery and the capacitor becomes extremely small. As a result, even if a semiconductor relay with a small current capacity, small size, and low cost is used as the connection switching means, it will not be damaged, and further, the miniaturization of the power storage device and the reduction of manufacturing costs can be achieved.

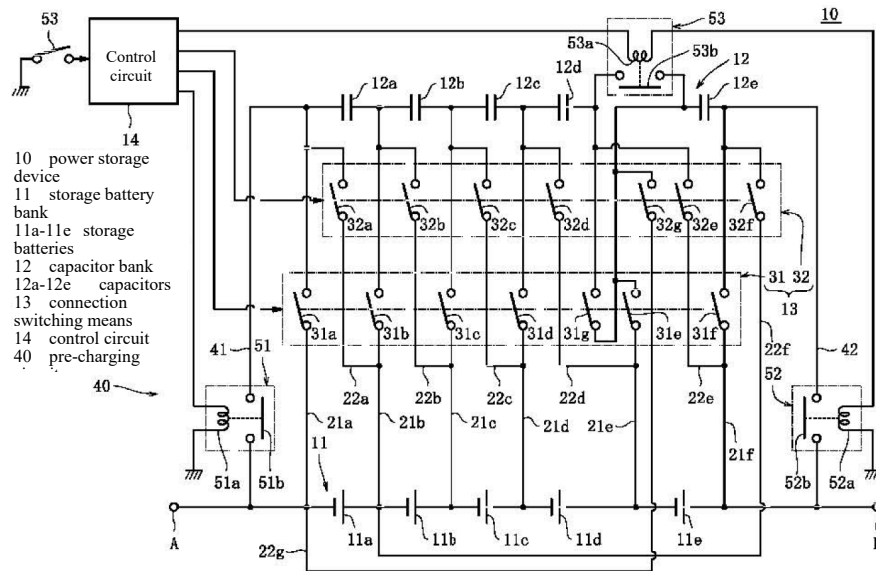
[Brief Description of the Drawings]

[Figure 1] is a circuit configuration diagram of the power storage device of an embodiment of the present invention.

[Explanation of References]

- 10 power storage device
 11 storage battery bank
 11a-11e storage batteries
 12 capacitor bank
 12a-12e capacitors
 13 connection switching means
 14 control circuit
 40 pre-charging circuit
 51, 52, 53 pre-charging switch

[Figure 1]



Continued from the front page

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						5H115 PA15 PG04 PI16 P001 PV22
						QN12 TR19 TU02



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