

VS1型户内高压真空断路器

TYPE VS1 INDOOR HIGH VOLTAGE VACUUM CIRCUIT BREAKER

安装使用说明书

Installation and Operation Manual

浙江昊鑫电力科技有限公司

ZHEJIANG HOSSIN ELECTRIC POWER

TECHNOLOGY CO., LTD.

注意!
Attention!

请严格遵守使用规程和操作规程。
Please comply with the use regulations and operating criterions strictly.

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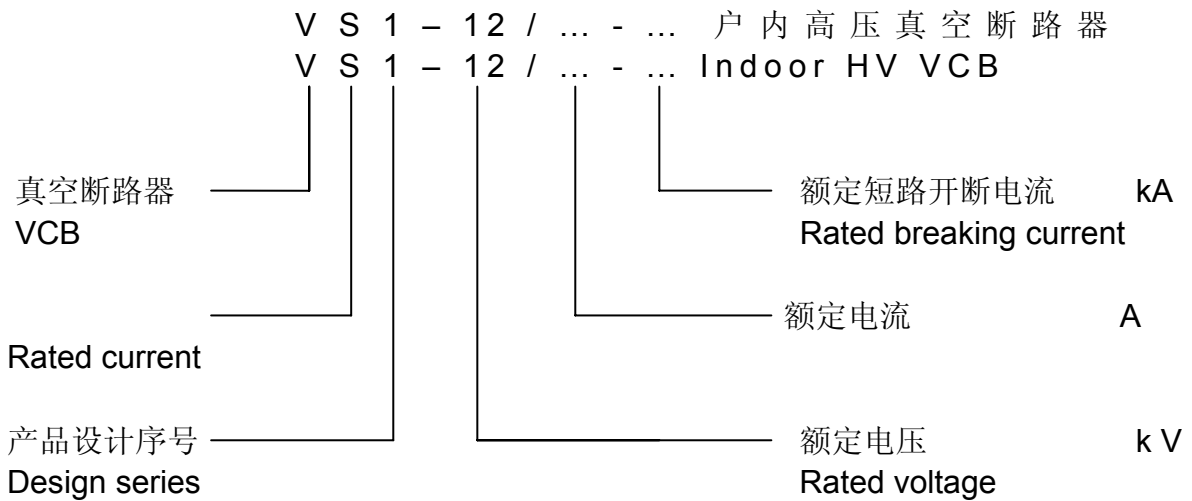
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1. 概述

Summarizing

1.1 总则

General



VS1 型户内高压真空断路器是三相交流 50Hz,额定电压为 7.2~12 千伏户内高压开关设备,符合我国国家标准 GB1984-89«交流高压断路器»、JB3855-96«3.6-40.5kV 户内交流高压真空断路器»、DL403-91«10~35kV 户内高压真空断路器订货技术条件»和国际电工委员会 IEC56 (1987 版)«交流高压断路器»的有关规定。

VS1 type indoor high voltage vacuum circuit breaker is one of three phase 50Hz, 7.2 to 12 kV indoor high voltage switchgear, it is compliance with Chinese nation standard GB 1984-89 <<Alternating current high-voltage circuit-breaker>>, JB3855-96 <<3.6-40.5kV Indoor alternating current high-voltage circuit-breaker>>, DL403-91 <<Specification of 10~35kV indoor alternating current high-voltage circuit-breaker>> and IEC56 <<Alternating current high-voltage circuit-breaker>> (1987) .

本公司生产的 VS1 型户内高压真空断路器属于第五代 VS1 产品,具有可靠的联锁功能,可进行频繁的操作,具有多次开断和快速重合闸能力。断路器由操动机构与灭弧室前后布置组成统一整体,既可以作为固定安装的单元,也可与底盘车配装作单独手车使用。

The VS1 type VCB manufactured by our company is of fifth generations product, it is with reliable interlock functions, suitable for frequent operation, also with many times of breaking and quick re-close capacity. The VCB consists of operating mechanism and arc-extinguish chambers in front-back arrangement, it can either be used as a fixed installation unit or as an individual VCB carriage together with a base-cart.

1.2 技术数据

Technical data

a. 机械特性参数
Mechanical parameters

序号 No.	名称 Name	单位 Unit	数值 Data			
1	触头开距 Clearance between open contacts	mm	11 ± 1			
2	接触行程 Over travel of moving contact		3.5 ± 0.5			
3	三相分闸同期性 Three poles asynchronous time at opening	ms	≤ 2			
4	合闸触头弹跳时间 Moving contact bounce time at closing		≤ 2			
5	分闸时间 Open time		20-50			
6	合闸时间 Close time		30-70			
7	平均分闸速度 Average opening speed	m/s	0.9~1.2			
8	平均合闸速度 Average closing speed		0.6~0.8			
9	合闸触头接触压力 Connecting pressure of close contacts	N	20kA	25kA	31.5kA	40kA
			2000 ± 200	2400 ± 200	3100 ± 200	4250 ± 250
10	动、静触头允许磨损累计厚度 Accumulative abrasion depth allowed of fixed and moving contacts	mm	3			

b. 断路器主要技术参数
Main technical parameters of VCB

序号 No.	名称 Name	单位 Unit	数值 Data			
1	额定电压 Rated voltage	kV	12			
2	额定短时工频耐受电压 (1min) Rated power frequency withstand voltage (1 min.)		42/48 (有效值) 42/48 (rms)			
3	额定雷电冲击耐受电压 (峰值) Rated lightning impulse withstand voltage (peak)		75/85 (峰值) 75/85 (peak)			
4	二次回路工频耐受电压 Power frequency withstand voltage of secondary circuit	kV	2			
5	额定频率 Rated frequency	Hz	50			
6	额定电流 Rated current	A	630 125 0	630 1250	1250 1600 2000 2500 3150	1250 1600 2000 2500 3150
7	额定短路开断电流 Rated breaking current	kA	20	25	31.5	40
8	额定短时耐受电流 Rated short time withstand current		20	25	31.5	40
9	额定峰值耐受电流 Rated peak withstand current		50	63	80	100
10	额定短路关合电流 Rated short circuit making current		50	63	80	100
11	额定电容器组关合涌流 Rated capacitors bank making current	12.5 (频率不大于 1000Hz) 12.5 (frequency not more than 1000Hz)				
12	额定单个/背对背电容器组开断电流 Rated breaking current of single / back to back capacitor bank	A	630/400 (40 kA 为 800/400) 630/400 (800/400 for 40kA)			

序号 No.	名称 Name	单位 Unit	数值 Data
13	额定短路持续时间 Rated short circuit duration	s	4
15	机械寿命 Mechanical endurance	次 Times	20000
16	额定电流开断次数（电寿命） Breaking times of rated current (electrical life)		20000
17	额定短路电流开断次数 Breaking times of rated short circuit current		50/30 (40kA)
18	额定操作顺序 Rated operation sequence		分—0.3 s—合分—180 s—合分 O - 0.3 s - CO - 180 s - CO 分—180 s—合分—180 s—合分 (40kA) O - 180 s - CO - 180 s - CO (40kA)
19	额定操作电压 Rated operation voltage	V	AC110/220 DC110/220
20	分闸脱扣器正常工作电压范围 Normal voltage range of trip coil		65%~120%额定操作电压 65%~120% rated operation voltage
21	合闸脱扣器正常工作电压范围 Normal voltage range of close coil		65%~120%额定操作电压 65%~120% rated operation voltage
22	储能电机正常工作电压范围 Normal voltage range of charging motor		85%~110%额定操作电压 85%~110% rated operation voltage
23	分合闸脱扣器额定功率 Rated power of trip and close coil	W	220
24	储能电机额定功率 Rated power of charging motor		75
25	储能时间 Charging time	s	≤10

1.3 外形尺寸 Externality dimension

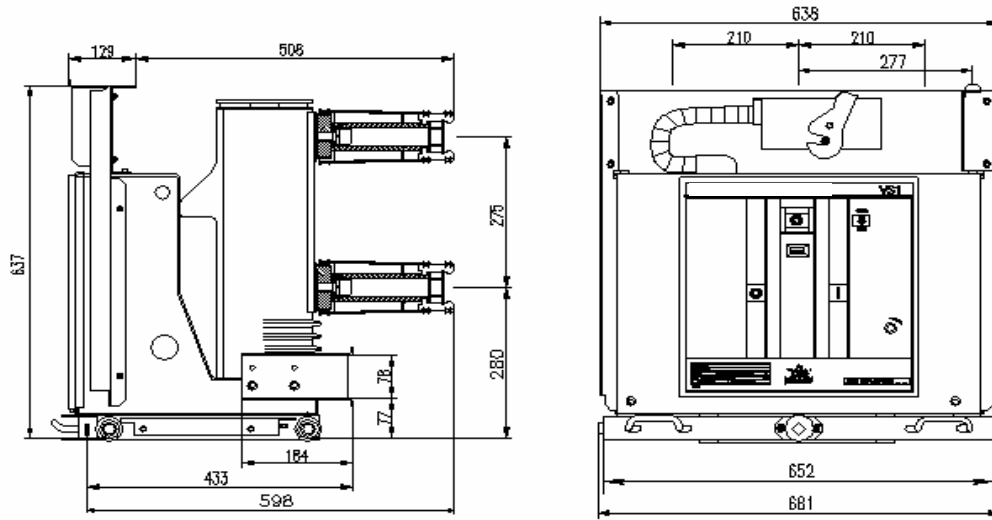


图 1: 手车式 VS1 外形尺寸图
Fig. 1: Externality dimension of VS1 with cart

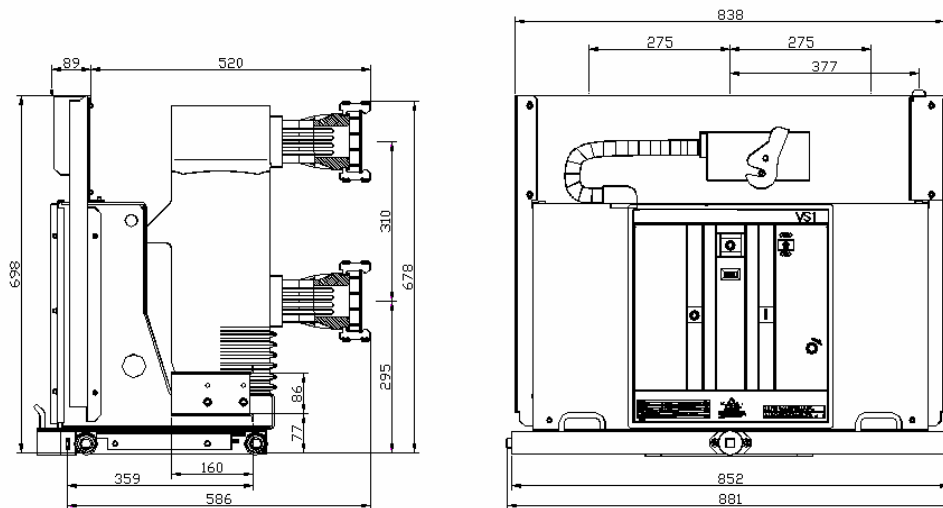
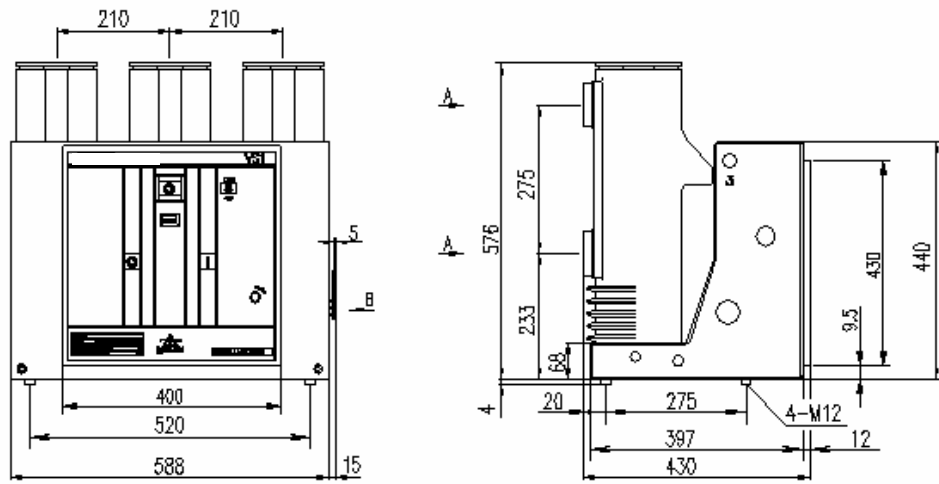
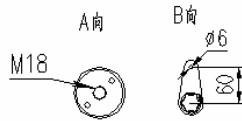


图 2: 手车式 VS1 外形尺寸图 (额定电流大于等于 1600A)
Fig. 2: Externality dimension of VS1 with cart (for $I_n \geq 1600A$)



A direction B direction

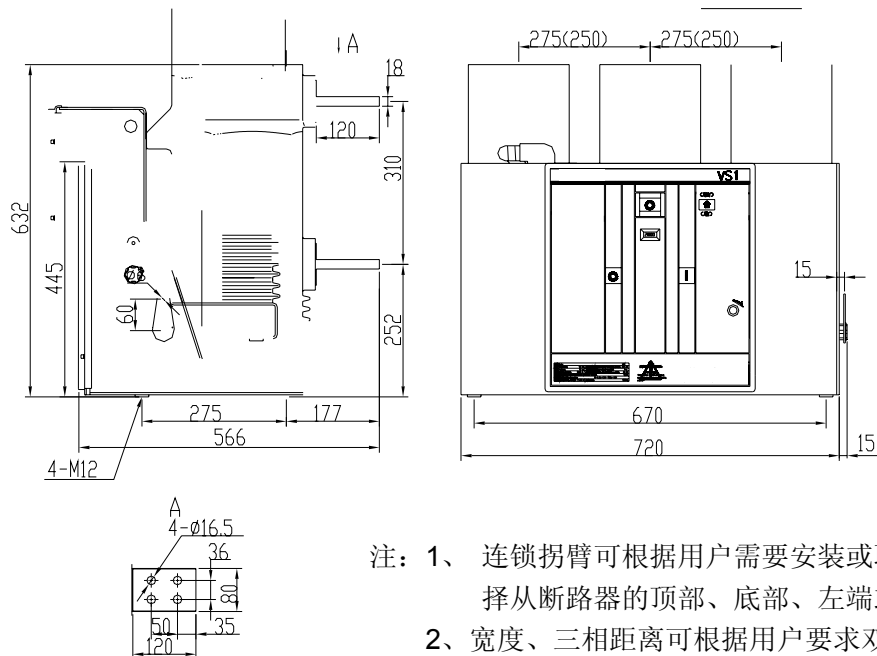


注：1、 连锁拐臂可根据用户需要安装或取消，并且可以选择从断路器的顶部、底部、左端或右端进行连锁；
2、 宽度、三相距离可根据用户要求双方协商调整。

Note: 1 The lock-arm can be fitted or removed according to client's requirement, and the lock can be on the top or bottom and the left side or the right side of VCB
2 The width and the three poles distances can be change under the negotiation of both sides if required.

图 3： 固定式 VS1 外形尺寸图

Fig. 3: Externality dimension of fixed type VS1



注：1、 连锁拐臂可根据用户需要安装或取消，并且可以选择从断路器的顶部、底部、左端或右端进行连锁；
2、 宽度、三相距离可根据用户要求双方协商调整。

Note: 1 The lock-arm can be fitted or removed according to client's requirement, and the lock can be on the top or bottom and the left side or the right side of VCB
2 The width and the three poles distances can be change under the negotiation of both sides if required.

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图 4： 固定式 VS1 外形尺寸图（额定电流大于等于 1600A）

Fig. 4: Externality dimension of fixed type VS1 (In ≥ 1600A)

1.4 使用环境条件

Ambient condition

a. 正常使用条件

Normal service condition

环境温度

Environment temp.

最高温度+ 40℃

Max. temp. +40℃

最低温度- 15℃

Min. temp. -15℃

环境湿度

Environment humidity

日平均相对湿度 95%及以下

Relative humidity per day $\leq 95\%$

月平均相对湿度 90%及以下

Relative humidity per month $\leq 90\%$

断路器装置地点的海拔高度高可达 1000m

Altitude of site where the VCB service in can reach 1000m

b. 特殊使用条件

Special service condition

客户若偏离正常使用条件可与本公司协商制造。

For special service condition, please contact manufacturer.

2、结构

Structure

VS1 型户内高压真空断路器总体结构采用操动机构和灭弧室前后布置的形式，主导电回路部分为三相落地式结构。真空灭弧室纵向安装在一个管状的绝缘筒内，绝缘筒由环氧树脂采用 APG 工艺浇注而成，因而它特别抗爬电。这种结构设计，大大地减小了粉尘在灭弧室表面聚积，不仅可以防止真空灭弧室受到外部因素的影响，而且可以确保即使在湿热及严重污秽环境下，也可对电压效应呈现出高阻态。

VS1 type VCB consist of operating mechanism and arc-extinguish chambers in front-back arrangement, its main conductive circuit is of floor model structure. The vacuum arc-extinguish chamber is fixed in a vertical cannular insulation column made of epoxy resin by APG technology, therefore with very good anti-creepage. Such structure design greatly reduces the accumulation of dusts on the surface of vacuum arc-extinguish chamber, it not only can prevent the vacuum extinguish chamber from

outside influence, but also can ensure to present high resistance state against the voltage effect even in warm-wet climate or heavy pollution environment.

操动机构为平面布置的弹簧操动机构，具有手动储能和电动储能，操动机构置于灭弧室前的机箱内，机箱被四块中间隔板分成五个装配空间，其间分别装有操动机构的储能部分、传动部分、脱扣部分和缓冲部分。VS1 型户内高压真空断路器将灭弧室与操动机构前后布置组成统一整体，即采用整体型布局，这种结构设计，可使操动机构的操作性能与灭弧室开合所需性能更为吻合，减小不必要的中间环节，降低了能耗和噪声，使 VS1 型户内高压真空断路器的操作性能更为可靠。

The spring operating mechanism arranged in plane disposal can be charged by manual or motor, the operating mechanism located in the iron box fixed in front of arc-extinguish chamber, the box is divided into five assembly space by four clapboards, in these spaces there are charging section, driving section, releasing section and buffer of mechanism separately. The structure of VS1 type VCB which the operating mechanism and arc-extinguish chambers are arranged into an integrated front-back layout can match well the operating performance of operating mechanism and the performance needed for breaking and making of arc-extinguish chamber, also can reduce the needless midway tache and reduce the noise and energy consumed therefore to lead the operation performance of VS1 much reliable.

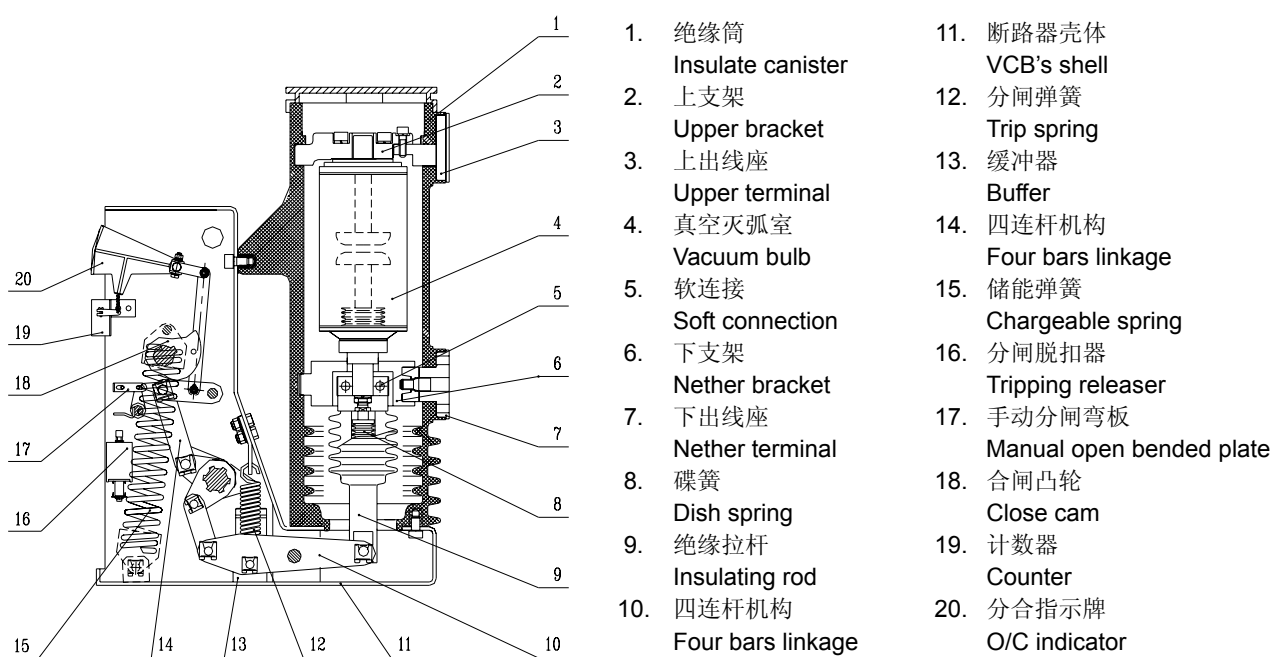
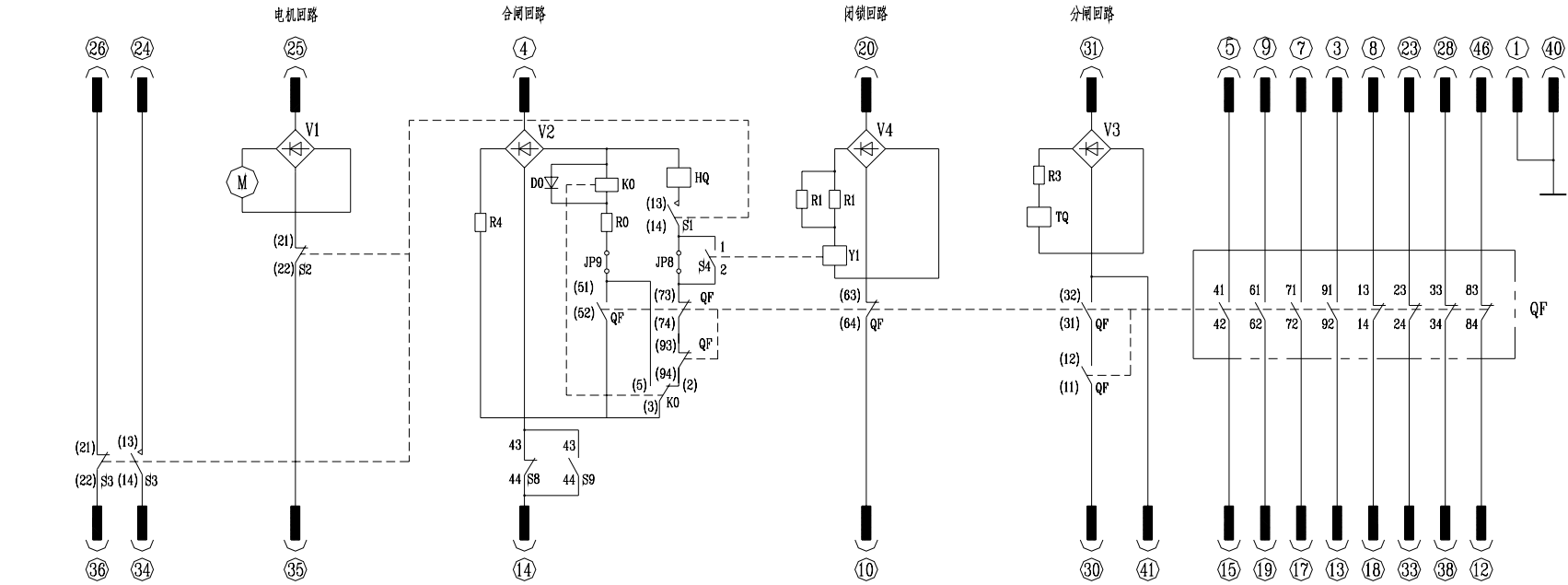


图 5: VS1 结构示意图

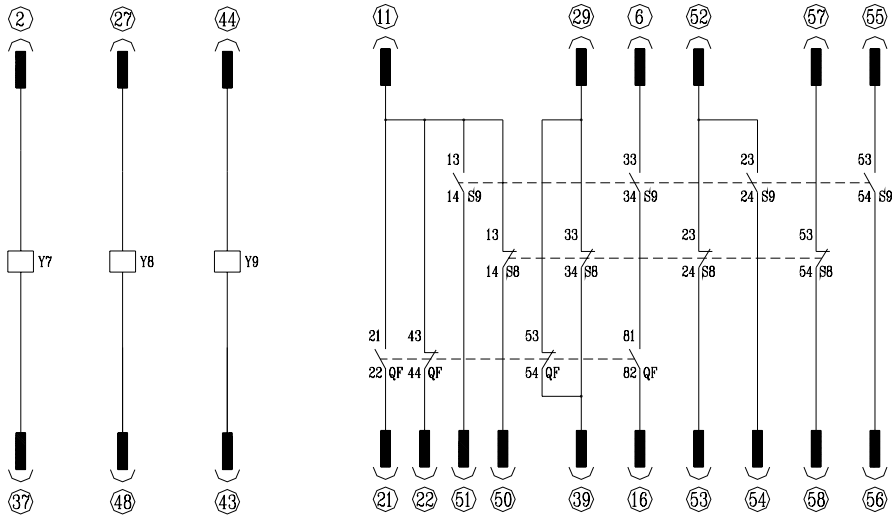
Fig. 5 Structure scheme of VS1

3、内部电气接线原理图 Inner electrical control scheme



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过流脱扣(A相) 过流脱扣(C相) 过流脱扣(B相)



可选项跳线设置

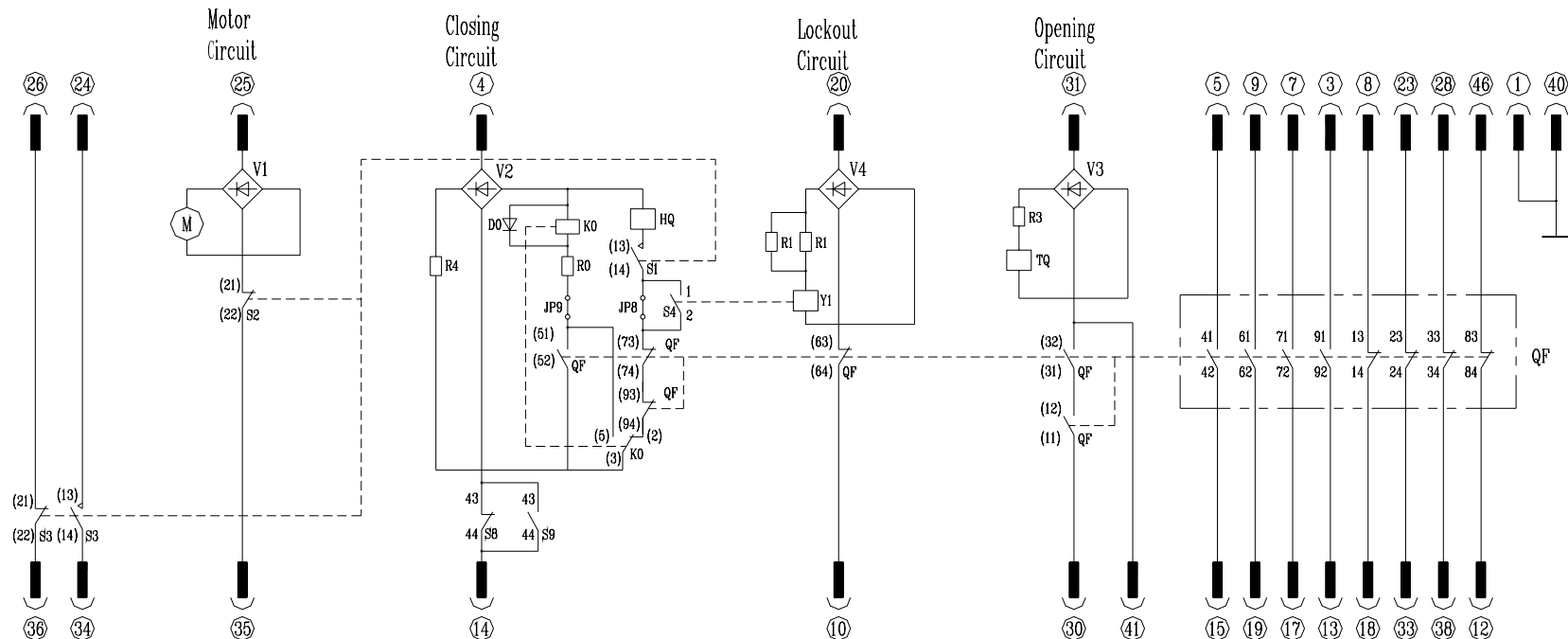
配置	跳线	
	跳线状态	跳线
带防跳	带闭锁	/
	无闭锁	✓
无防跳	带闭锁	/
	无闭锁	✓

注：“✓”表示连接；
“/”表示断开。

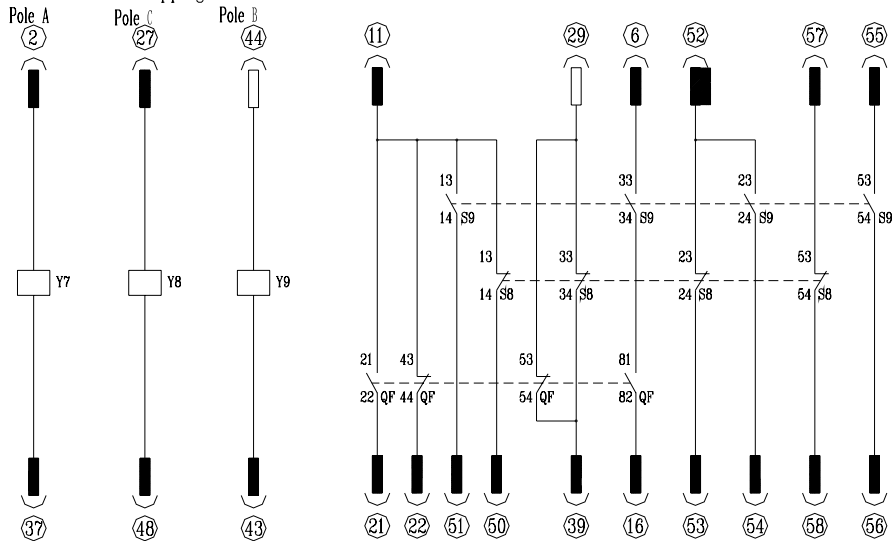
- | | | | |
|------------|------------------|------------|-----------------|
| 1 M | 储能电机 | 9 R0~R4 | 限流电阻 |
| 2 TQ | 分闸电磁铁 | 10 D0 | 二极管 |
| 3 HQ | 合闸电磁铁 | 11 KO | 机构内部防跳继电器 (可选件) |
| 4 QF | 与断路器主轴联动辅助开关 | 12 Y1 | 闭锁电磁铁 (可选件) |
| 5 S1.S2.S3 | 储能用微动开关 | 13 Y7 | 间接式过电流脱扣器 (可选件) |
| 6 S4 | 闭锁电磁铁的辅助开关 (可选件) | 14 S8 | 试验位置行程开关 |
| 7 P | 手动操作机构 | 15 S9 | 工作位置行程开关 |
| 8 V1 ~ V7 | 整流元件 | 16 JP8,JP9 | 跳线 |

注：断路器处于试验位置、未储能、分闸状态。

图6：手车式VS1内部接线原理图（交流标准方案：OSSY.364.009）



Over Current Tripping



Optional Jumping

Deploy	Jumping State		JP8	JP9
	With Locking	Without Locking		
With Anti-Bouncing	✓	✓	✓	✓
Without Anti-Bouncing	✓	✓	✓	✓

Note:
 " ✓ " Connected
 " / " Disconnecting

- | | | | |
|------------|--|------------|---|
| 1 M | Charging motor | 9 R0~R4 | Resistor |
| 2 TQ | Tripping coil | 10 DO | Diode |
| 3 HQ | Closing coil | 11 KO | Anti-pumping relay (optional) |
| 4 QF | Aux.switch linked to Main shaft of VCB | 12 Y1 | Locking electromagnet |
| 5 S1.S2.S3 | Micro switch | 13 Y7~Y9 | Over current tripping device (optional) |
| 6 S4 | Aux.switch of locking device(optional) | 14 S8 | Test position switch |
| 7 P | Manual mechanism | 15 S9 | Working position switch |
| 8 V1 ~ V4 | Rectifier | 16 JP8,JP9 | Jumping wire |

Note: VCB is in test position and is opened and uncharged.

Fig. 6 The control scheme of VS1 with carriage (AC standard plan: 0SSY.364.009)

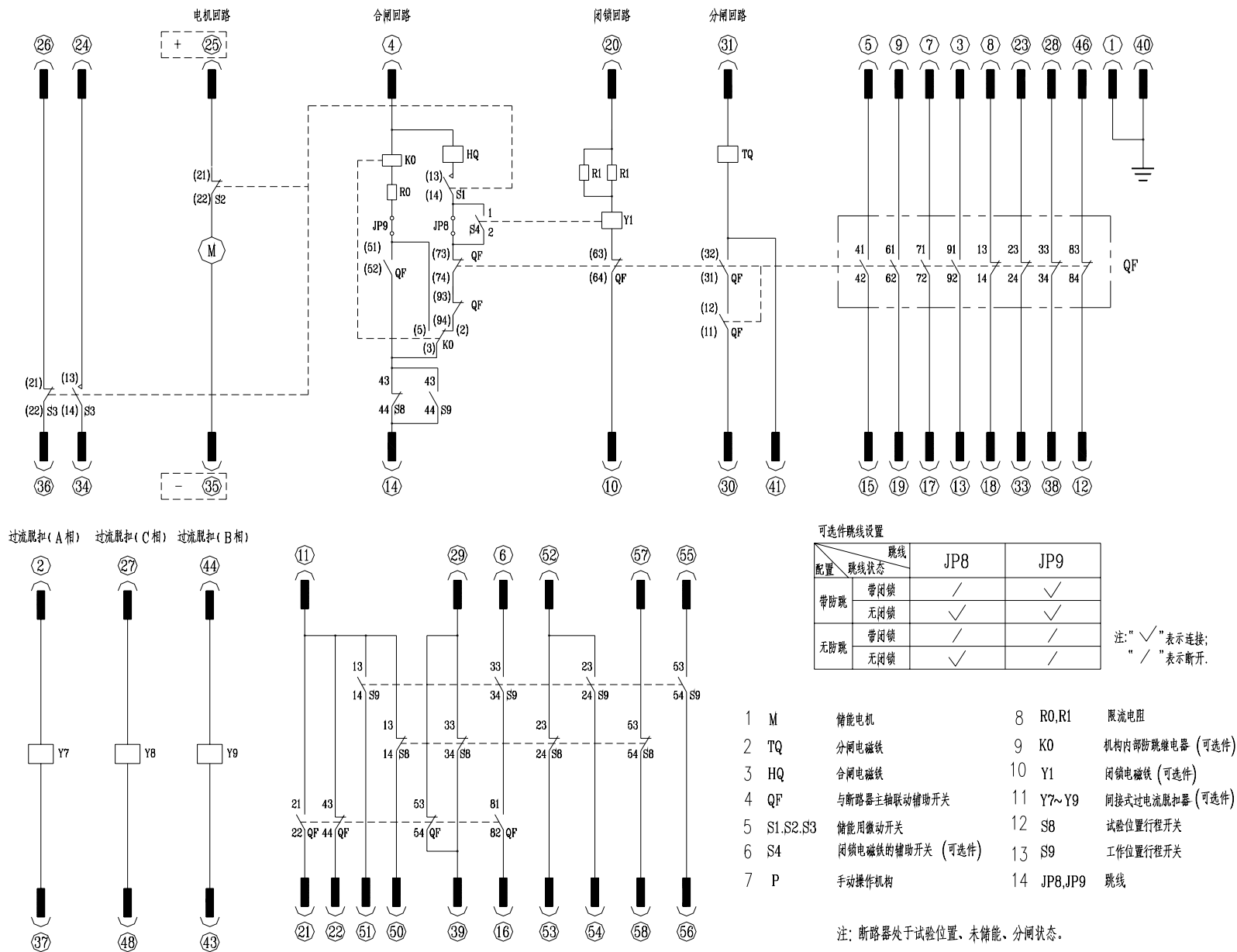
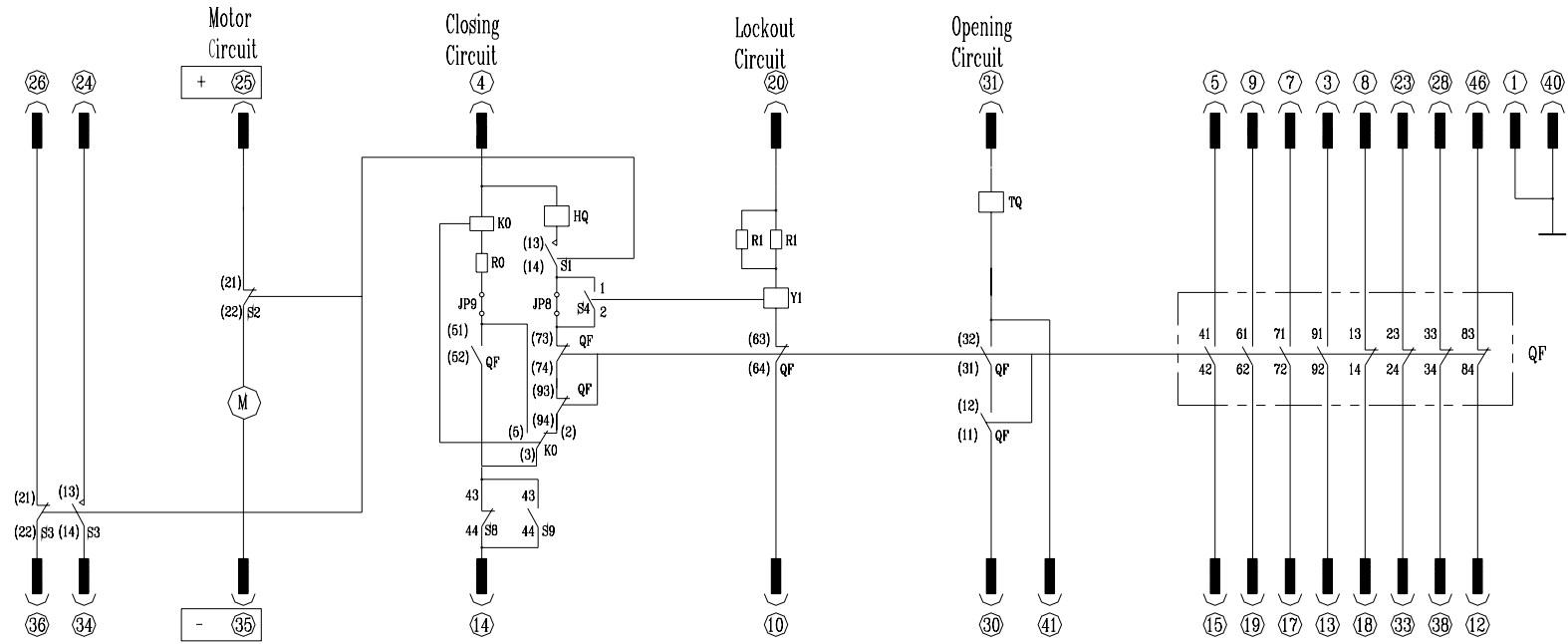
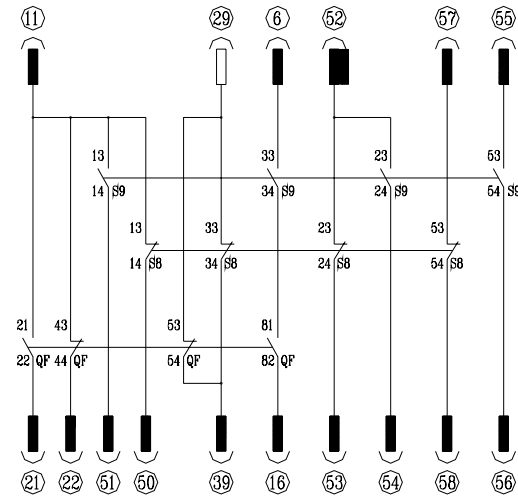
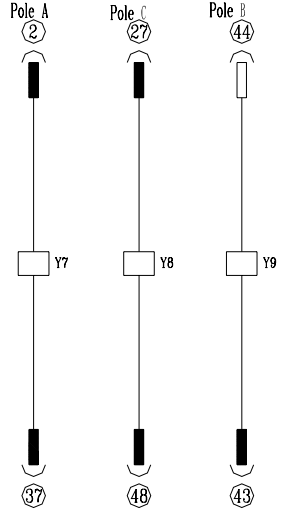


图7：手车式VS1内部接线原理图(直流闭锁方案:0SSY.364.209)



Over Current Tripping



Optional Jumping

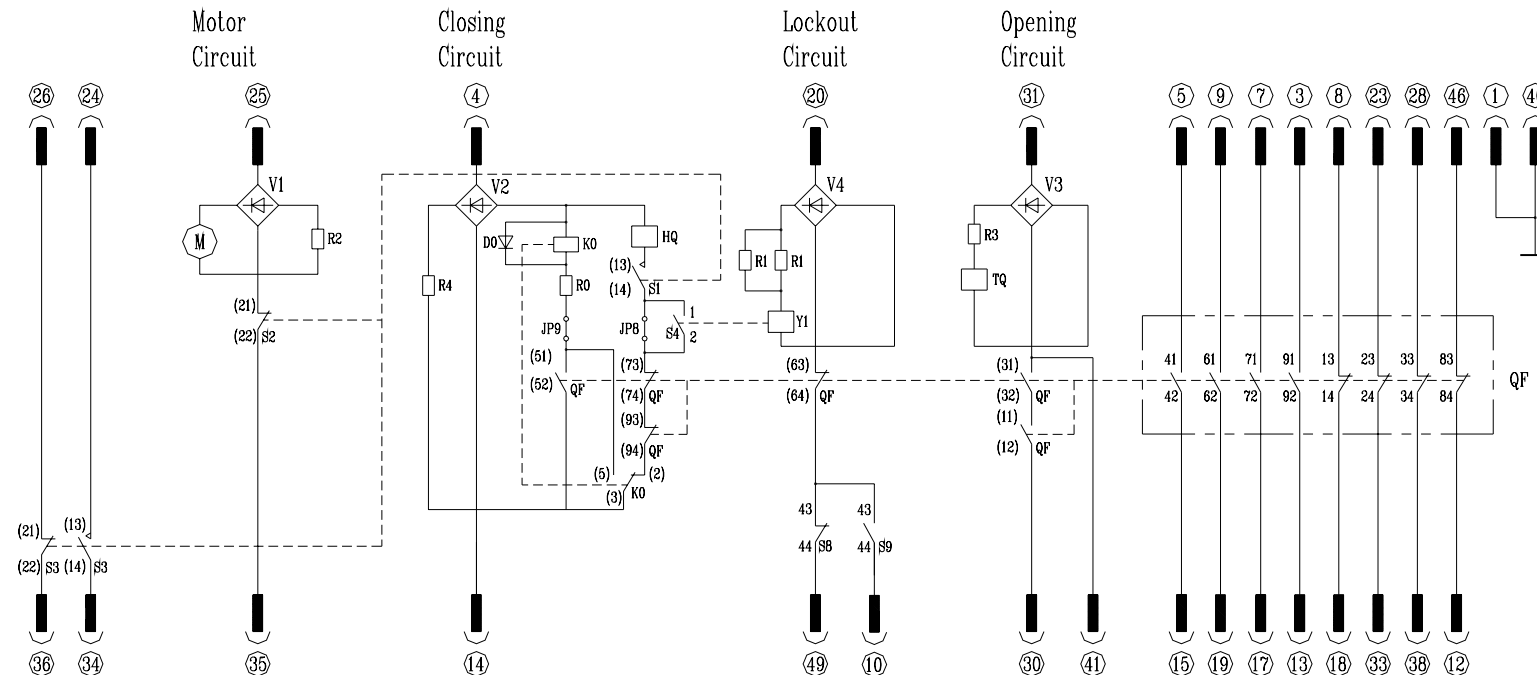
		Jumping	
		JP8	JP9
Deploy	With Locking	/	✓
	Without Locking	✓	✓
	With Anti-Bouncing	/	/
	Without Anti-Bouncing	✓	/

Note:
 " ✓ " Connected
 " / " Disconnecting

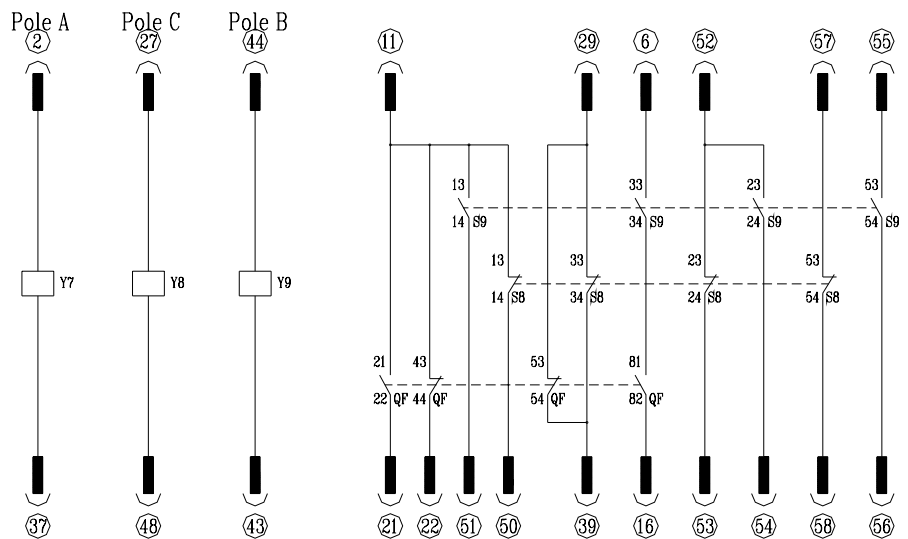
- 1 M Charging motor
- 2 TQ Tripping coil
- 3 HQ Closing coil
- 4 QF Aux. switch linked to Main shaft of VCB
- 5 S1, S2, S3 Micro switch
- 6 S4 Aux. switch of locking device (optional)
- 7 P Manual mechanism
- 8 R0, R1 Limit resistor
- 9 KO Anti-pumping relay (optional)
- 10 Y1 Locking electromagnet (optional)
- 11 Y7~Y9 Over current tripping device (optional)
- 12 S8 Test position switch
- 13 S9 Working position switch
- 14 JP8, JP9 Jumping wire

Note: VCB is in test position and is opened and uncharged.

Fig. 7 The control scheme of VS1 with carriage (DC standard plan: 0SSY. 364. 209)



Over current Tripping



Optional Jumping

Deploy	Jumping		JP8	JP9
	Jumping	State		
With Anti-Bouncing	With Locking	/	/	✓
Without Anti-Bouncing	With Locking	/	/	/

Note:
 "✓" Connected
 "/" Disconnecting

- 1 M Charging motor
- 2 TQ Tripping coil
- 3 HQ Closing coil
- 4 QF Aux.switch linked to Main shaft of VCB
- 5 S1.S2.S3 Micro switch
- 6 S4 Aux.switch of locking device(optional)
- 7 P Manual mechanism
- 8 V1 ~ V4 Rectifier
- 9 R0~R4 Resistor
- 10 DO Diode
- 11 K0 Anti-pumping relay (optional)
- 12 Y1 Locking electromagnet
- 13 Y7~Y9 Over current tripping device (optional)
- 14 S8 Test position switch
- 15 S9 Working position switch
- 16 JP8,JP9 Jumping wire

Note: VCB is in test position and opened and uncharged.

Fig. 8: The control scheme of VS1 with carriage (AC lockout plan: OSSY.364.009.2)

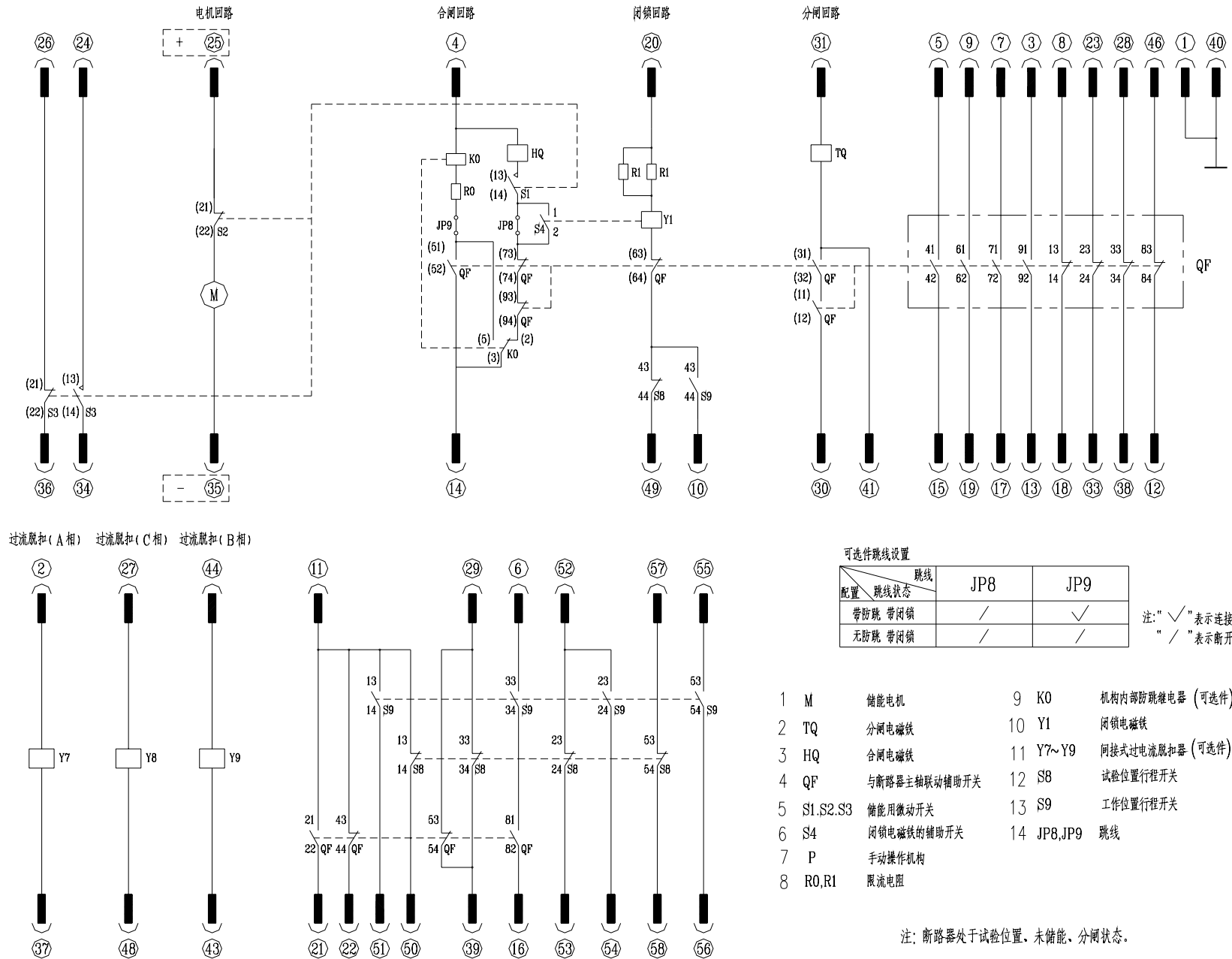
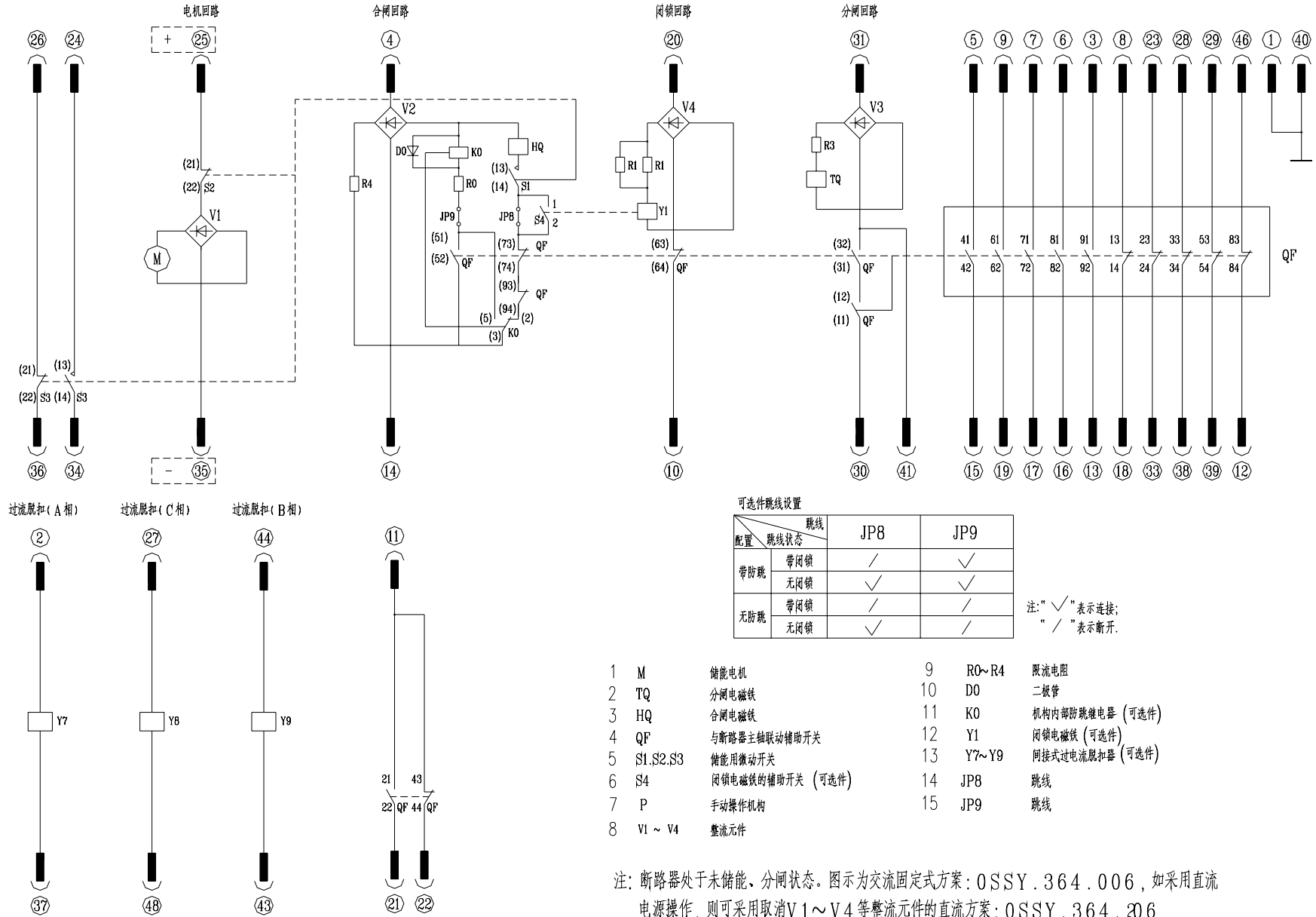


图9: 手车式VS1内部接线原理图(直流闭锁方案: 0SSY.364.209.2)



可选件跳线设置

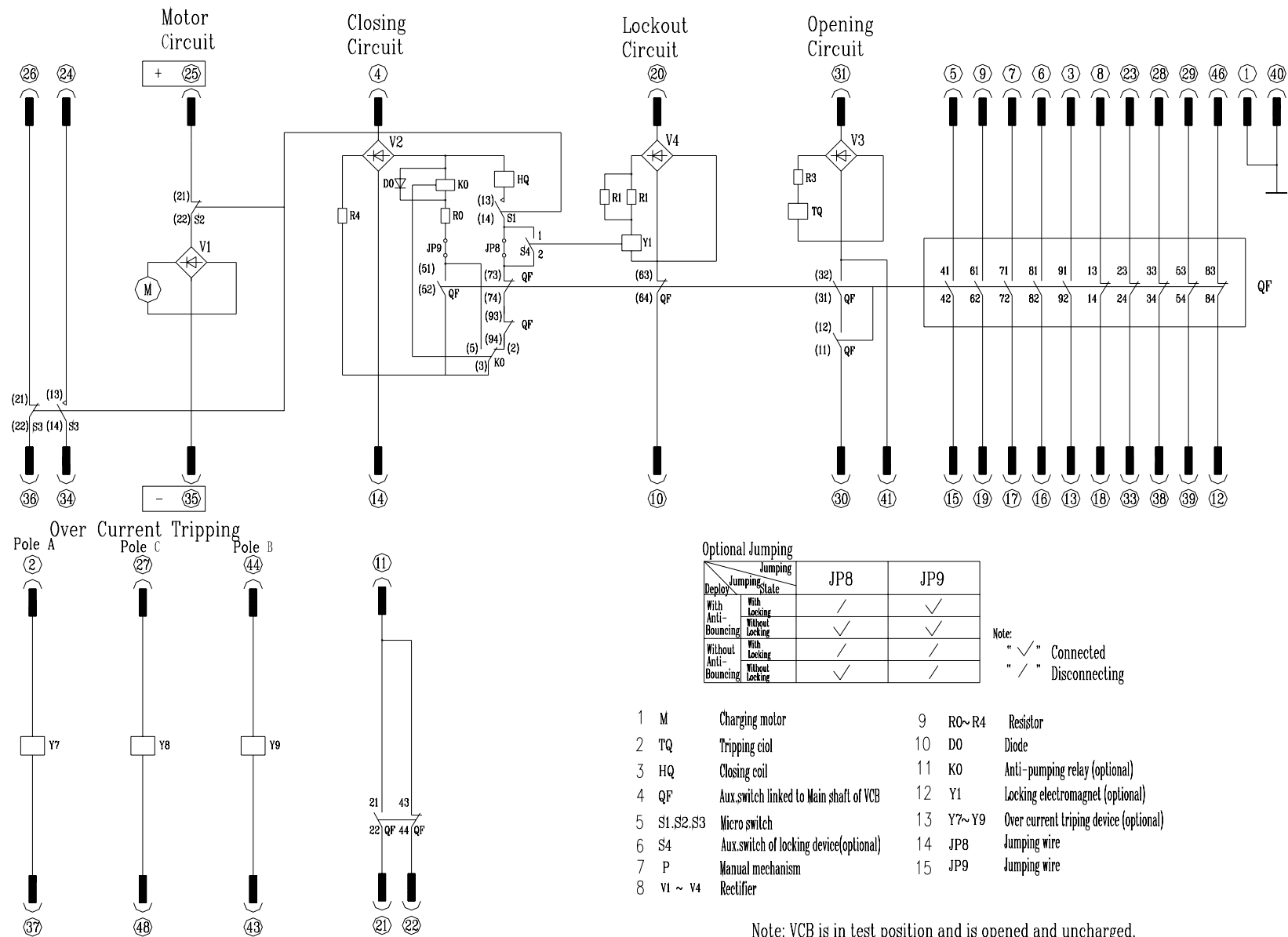
配置	跳线	
	跳线状态	
带防跳	带闭锁	/
	无闭锁	✓
无防跳	带闭锁	/
	无闭锁	✓

注：“✓”表示连接；
“/”表示断开。

- | | | | |
|------------|------------------|----------|-----------------|
| 1 M | 储能电机 | 9 R0~R4 | 限流电阻 |
| 2 TQ | 分闸电磁铁 | 10 D0 | 二极管 |
| 3 HQ | 合闸电磁铁 | 11 KO | 机构内部防跳继电器 (可选件) |
| 4 QF | 与断路器主轴联动辅助开关 | 12 Y1 | 闭锁电磁铁 (可选件) |
| 5 S1.S2.S3 | 储能用微动开关 | 13 Y7~Y9 | 间接式过电流脱扣器 (可选件) |
| 6 S4 | 闭锁电磁铁的辅助开关 (可选件) | 14 JP8 | 跳线 |
| 7 P | 手动操作机构 | 15 JP9 | 跳线 |
| 8 V1 ~ V4 | 整流元件 | | |

注：断路器处于未储能、分闸状态。图示为交流固定式方案：0SSY.364.006，如采用直流电源操作，则可采用取消V1~V4等整流元件的直流方案：0SSY.364.206

图 10：固定式VS1 内部接线图



- 1 M Charging motor
- 2 TQ Tripping coil
- 3 HQ Closing coil
- 4 QF Aux.switch linked to Main shaft of VCB
- 5 S1,S2,S3 Micro switch
- 6 S4 Aux.switch of locking device(optional)
- 7 P Manual mechanism
- 8 V1 ~ V4 Rectifier
- 9 R0~R4 Resistor
- 10 DO Diode
- 11 KO Anti-pumping relay (optional)
- 12 Y1 Locking electromagnet (optional)
- 13 Y7~Y9 Over current tripping device (optional)
- 14 JP8 Jumping wire
- 15 JP9 Jumping wire

Note: VCB is in test position and is opened and uncharged.
 The scheme shown is for AC operation. (No. OSSY . 364 . 006)
 For DC operation, the scheme No. OSSY.364.206 which the rectifiers of V1 TO V4 have been removed in can be used.

Fig. 10 The control scheme of fixed type VSI

4、调试与操作

Adjustment and operation

调试和操作中的各项工作应由受过专业培训、详细了解本开关设备性能的人员进行，工作中必须考虑相应的保护和预防措施。

Adjustment and operation should be done by the technical person who has professional trained and understands the equipment performance well. The relative protection and preventing measures should be taken into account.

4.1 准备工作

Preparing works

- a. 断路器开箱后，应检查固定真空灭弧室的绝缘筒有无破裂，产品铭牌合格证是否与订货单相符，装箱清单是否与实物相符；

After unpacking, make sure if any insulating canister used for fixing the vacuum arc-extinguish chamber is fault, if the nameplate of VCB and qualified certificate are compliance with the indent, if the packing list matches the practical equipment;

- b. 清理表面灰尘污垢，尤其是在绝缘体表面的污垢；

Clean the dust and dirt attached on equipment's surface, specially attached on the surface of insulating parts;

- c. 仔细核对各操作元件的额定电压是否与实际情况相符；

Check carefully if the rated operation voltage of all operating parts is accord with practical voltage;

- d. 手动储能，并进行手动合分闸操作，同时注意观察面板上相关的指示状态；

Charging the spring by manual then to perform the manual close and open, play attention to the indicating states on the faceplate;

- e. 卸去断路器上标识“运行前去除”的防尘、防护等附属件

Remove the attached covers used for dust-proof and protection marked with "Remove before operation"

4.2 断路器的操作

The operation of VCB

- a. 储能

Charging springs

手动储能：用 VS1 专用储能手柄伸入六角杆中，转动 20 圈左右，从储能指示观察窗中看到储能标记指向已储能。

Charging by manual: Insert the manual charging handle special for VS1 into the hexagon pole, then turn it about 20 circles, the charging indicator will move to charged position which can be checked from view window.

电动储能：储能电机通电时可以自动储能，储能到位后储能电机自动切断，储能标记指向已储能。

Motor charging: The motor will charge the spring automatically when the power putting on. After charging the motor will cut off automatically and the charging indicator will move to charged position which can be checked from view window.

b. 合闸与分闸

Closing and opening

合闸：操作断路器合闸按钮和电气控制元件。

Closing: Operate the close button and electric control components.

分闸：操作断路器分闸按钮和电气控制元件。

Opening: Operate the open button and electric control components.

每次分闸操作中断路器计数器自动进一数，从面板观察窗中观察相应的位置。

After each open operation the counter will increase one digit, it can be checked from view window located in the faceplate.

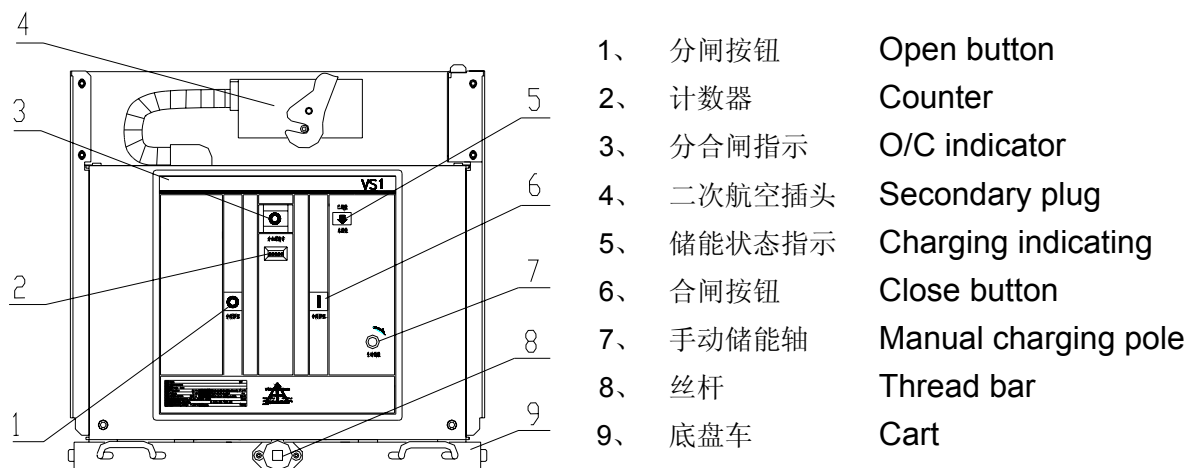


图 11：板面示意图

Fig. 11 Faceplate of VCB

5、断路器与柜体配合的实现方式

The matching of VCB and cubicle body

VS1 型户内高压真空断路器通过转运小车推入柜中。

VS1 type indoor VCB is pushed into cubicle body by transport carriage.

断路器底盘车锁板与柜体进入配合状态，此时断路器进到试验/隔离位置。用 VS1 专用推进手柄插入丝杆四方头中顺时针转动 20 圈，听到推进小车内部“嗒”的一声表示到达工作位置，同时柜体指示信号灯亮。整个摇进摇出过程用力必须均匀，以免用力过猛使联锁机构和辅助开关受损。只能在工作位置和试验/隔离位置才能进行分合闸的操作，而且合闸后不能移动断路器手车。

When the lock plate of VCB cart comes into matching with cubicle body, the VCB is in test / isolation position. Insert the pushing handle special for VS1 into square head of thread bar and turn it 20 cycles clockwise, the sound of “da” will be heard when the cart has reached in its work position, the indicating lamp will light synchronously. During the whole push in, the force should be uniformity to prevent to damage the interlock mechanism and auxiliary switch from overexert. Only can the O / C operation of VCB be performed when it is in working position and test / isolation position, and should not move the VCB cart after closing.

VS1 型户内高压真空断路器按顾客的需要可以配置合闸闭锁，在二次电源不带电时，只可分闸操作，不可进行合闸操作；也可按顾客的需要配置过电流保护，机构的过电流脱扣器由电流互感器整定，其电路依靠分装的电流继电器触头动作闭合，过电流保护的動作电流由继电器整定。VS1 型户内高压真空断路器内部安装了防止多次重合的联锁装置。

The VS1 can be equipped with closing lock on requirement of clients, if the secondary circuit without power, only can the open operation be performed and can not close it; The over current protection can also be equipped with if required, the over current release is set by current transformer, the close of its circuit depends on the closing of contacts of current relay attached, the start current of over current protection is set by relay. The interlock device for preventing the repeated re-close of VCB is equipped in VS1.

6、储运

Store and transport

a、运输

Transport

VS1 型户内高压真空断路器是单独包装，固定于包装箱内并作相应的防护；在断路器外壳两侧各有一个明显标志标明起吊孔，作为起吊断路器之用；在起吊过程中保证不受冲击和机械操作应力的影响。

VS1 is packed and fixed in an individual box with suitable protection; there are two lifting holes with clear mark located in each side of VCB. During the lifting it must be ensured that the VCB should not be borne any impulse and mechanical stress.

b、仓储

Store

真空断路器在使用前必须储存在干燥、无尘埃及通风良好的场所，同时断路器必须处于分闸位置和未储能状态。

Before use, the VCB should be kept in dry, dust free and drafty place, and the VCB should be in opened and uncharged state.

7、维护与保养

Maintenance

- a.真空断路器在使用过程中应定时检查真空灭弧室的真空度，具体方法：把真空断路器分闸，以 42kV 工频电压施加到真空灭弧室的断口上并持续一分钟，如发现真空灭弧室有持续击穿现象，应更换真空灭弧室。

The vacuum of arc-extinguish chamber should be inspected periodically in service, the method is: open the VCB, apply the power frequency voltage of 42kV to its opened breaks, if the persistent flash-over phenomena appearance, the arc-extinguish chamber should be replaced by new one.

- b.真空断路器在使用过程中应定期维护，清除绝缘表面的灰尘污垢，摩擦和传动部位定期润滑。

During service the maintenance of VCB should be done periodically, to clean the dust and dirt on the insulation surface and to lubricate the friction and drive parts periodically.

- c.操作和维护人员应了解真空断路器的结构、性能和操作维护要求，严禁违规操作和野蛮操作。

The operator and maintenance person should understand the structure, functions and operation and maintenance requirement of VCB, The non-regulation or barbaric

operations have to strictly prohibit.

d. 用户不应擅自更换与原型号规格不一致的元器件。

The users do not self-assertively replace the components with that are difference from original one.

8、随机文件

Documents with delivery

a. 产品合格证;

Product qualified certificate

b. 出厂检验报告;

Routine test reports

c. 安装使用说明书;

Installation and operation manual

d. 装箱单.

Packing list

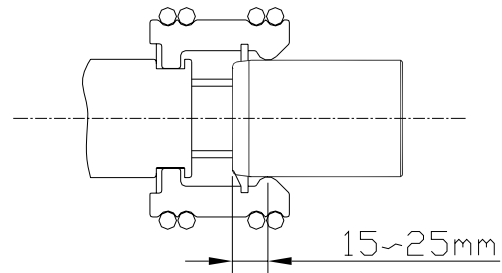


图12: 手车式VS1动静触头配合尺寸
Fig. 12: The matching of VS1's fixed & moving contacts

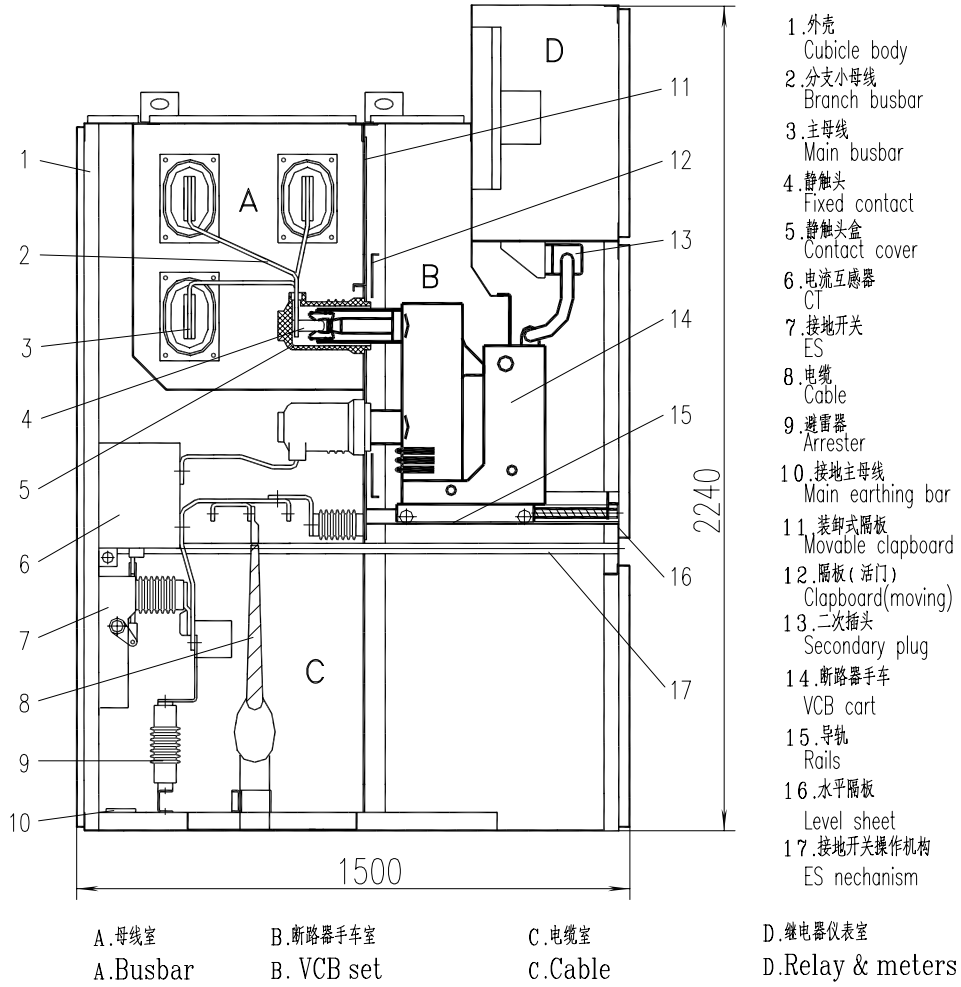


图12: 手车式VS1真空断路器配柜示意图
Fig. 12 Scheme of VS1 set fitted in switchgear

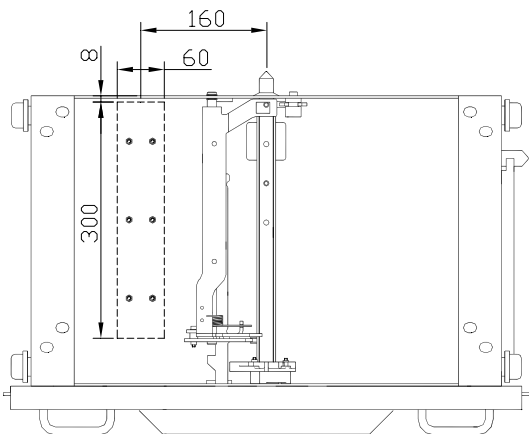


图14: 手车式VS1接地示意图
Fig. 14 Earthing scheme of VS1 in cart

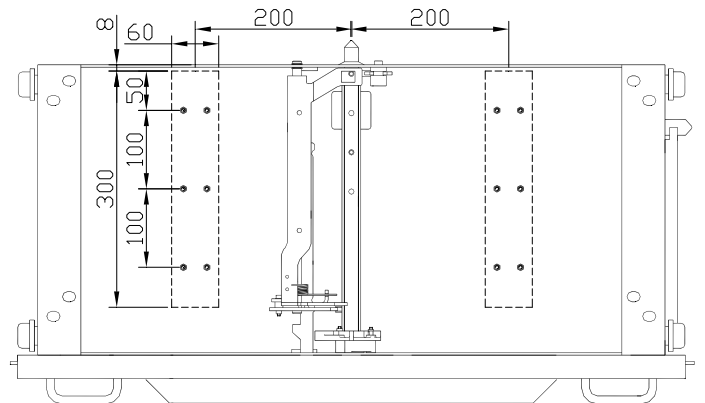


图15: 手车式VS1接地示意图 (额定电流大于等于1600A)
Fig. 15 Earthing scheme of VS1 in cart ($I_n \geq 1600A$)