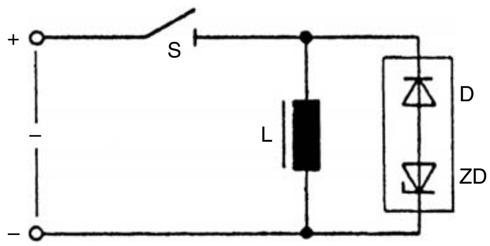
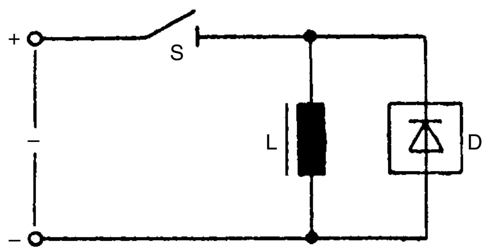
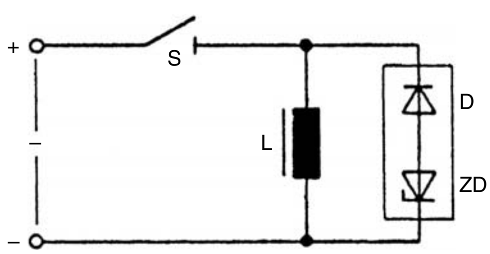
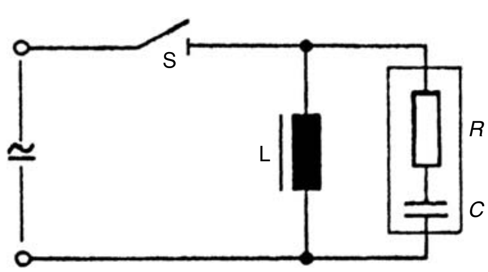
TABLE 3.3

Types and Features of Arc Protective Circuits

Protective Circuits	Commentary
	At circuit opening energy accumulated in inductance is discharged through resistance *R* Drawback of the circuit design: increase in current load of a contact
 Diode voltage must be 3 to 5 times as much as circuit voltage, maximum pulse current must not be less than load current	For DC circuits only EMF of load self-induction arising at circuit opening has direction opposite to the source, which is why the diode is blocked in the normal mode and unblocked only at the moment of contact opening and shunt inductance Drawback: increase in time of current drop in inductance. When dealing with a relay winding or a contactor — increase in time of relay drop-out
 Voltage of Zener diode must be not less than voltage of power source, Zener current must not be less than 0.5 to 0.7 of load current	This circuit design, when compared to the previous one, does not have much effect on time of current drop in load because Zener diode is blocked, thus preventing shunting of the load by diode when voltage rating value in circuit decreases Drawback: high cost of a Zener diode for power loads
	Popular type of protective circuits Does not have much influence on time of current drop in inductance. Energy of spark is used for condenser (*C*) charge. Resistance (*R*) restricts discharge of current of charged condenser at repeated contact closing Capacitance chosen is 0.5 to 1.0 μF for each ampere of switched current

(*Continues*)

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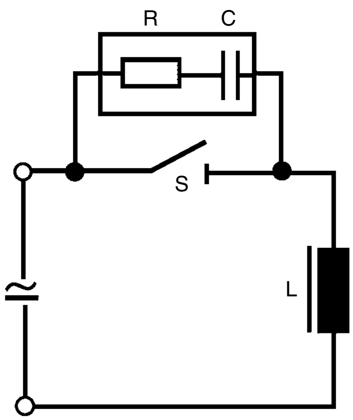
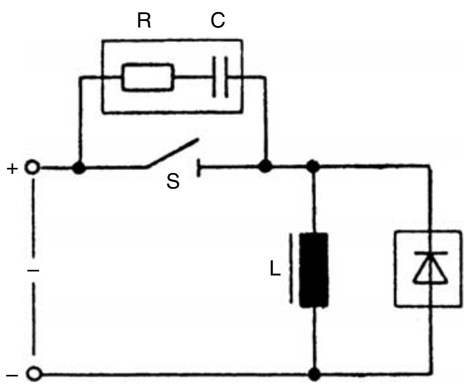
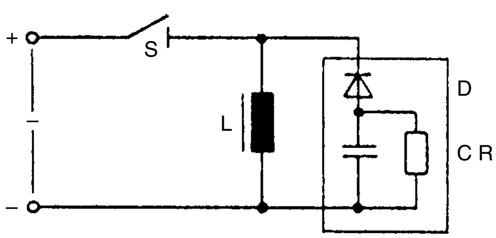
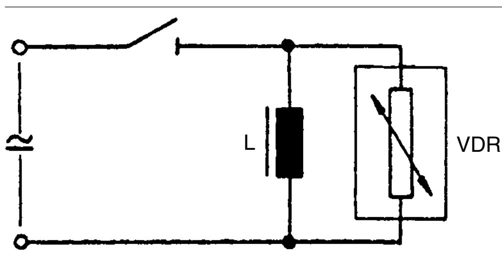
TABLE 3.3 (*Continued*)

Spark Protective Circuits and its Characteristics

Protective Circuits	Commentary
	Resistance is 0.5 to 1 Ω for each Volt of working voltage The condenser should be designed for work in AC circuit with voltage not less than that exceeding rating voltage by 1.5 to 2 times In the schematic below on AC current there is a leakage of current through RC circuits that can have an influence on the load
	For DC circuits only Compound schematic combining both advantages and disadvantages of the variants mentioned above
	For DC circuits only Very effective circuit design, which practically does not affect current drop in a load. Resistance connected parallel to a condenser does not make it less effective for absorbing of spark energy, and discharges quickly after voltage surge
 Classification voltage of a varistor must not be less than rayed voltage of circuit	Popular variant A varistor (VDR) is used. A varistor is a resistor with nonlinear resistance. Being affected by over-voltage its resistance considerably goes down Effectiveness depends on the proper choice of the varistor (voltage, dissipation energy) Has insignificant influence on time of current drop in the inductive load

(*Continues*)

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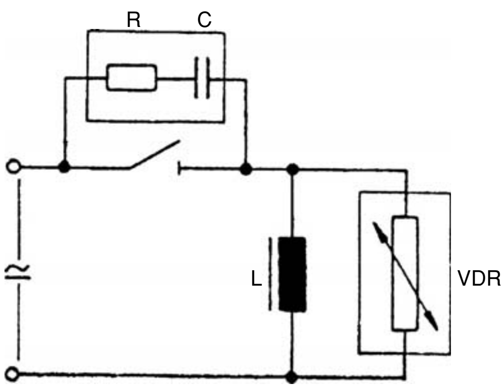
TABLE 3.3 (*Continued*)

Spark Protective Circuits and its Characteristics

Protective Circuits	Commentary
	Combined schematic combining both advantages and disadvantages of the variants described above

Some companies produce protective circuits as separate articles. Companies, manufacturers of relays, produce protective circuits in special cases for easy mounting on their relays (Figure 3.40).

It must be mentioned that gas-discharge processes arising on opening contacts are quite complex and this book is not aimed at a detailed consideration of these processes, which are described in extensive monographs, and although the author does not want to simplify these problems it is still possible to draw a generalization digressing from the complex theory: when current switched by the contacts and the voltage applied to the contacts exceed certain threshold values necessary for maintaining arcing, the electric-spark discharge turns into an arc and the means described above are ineffective for extinguishing it. Conditions for arcing are ambiguous and may depend on many factors (Table 3.4).

Moreover, different researchers have provided considerably different data, which nevertheless because it gives the reader some idea regarding the conditions, we will cite here concerning critical current of arcing (that is current exceeding the arcing point, which

TABLE 3.4

Critical Currents of Arcing for Different Materials of Contacts and Different Voltages on the Contacts

Material of Contacts	Critical Current of Arcing A for Voltage on Contacts, V			
	25	50	110	220
Copper	—	1.3	0.9	0.5
Silver	1.7	1.0	0.6	0.25
Gold	1.7	1.5	0.5	0.5
Platinum	4.0	2.0	1.0	0.5
Nickel	—	1.2	1.0	0.7
Zinc	0.5	0.5	0.5	0.5
Iron	—	1.5	1.0	0.5
Tungsten	12.5	4.0	1.8	1.4
Molybdenum	18.0	3.0	2.0	1.0

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