



Vladimir Gurevich

# Electric Relays:

- Principles
- Applications

CRC Press  
2005

If we do not find anything very pleasant,  
at least we shall find something new

Voltaire

Things should be described as simply as  
possible, but no simpler

A. Einstein

## **PREFACE**

The electric relay is one of the most frequently used devices in modern technological systems. It can be found in cars, washing machines, microwave ovens and medical equipment, as well as in tanks, aircraft and ships. Practically no industry would function without relays. In some complex automatic control systems in industry, the number of relays is estimated in the hundreds and even thousands. In the power-generation industry, no power device is allowed to operate without special protection relays. Certain electrical equipment, such as power transformers, may be protected by several different kinds of relays, each controlling different functions.

Because relays are so widely used and there are so many types, the broad population of engineers is unfamiliar with most of them. Generally speaking, engineers in a specific technical field are usually only familiar with relays that are applicable for specific devices. The same is true of specialists involved in the design and production of relays. Therefore, obtaining information on relays is a problem both for students whose future profession involves relay application, and for teachers in technical colleges or extension courses, who need up-to-date information about relays for their students.

Where can we find extensive publications that equally meet the needs of engineers, teachers and students?

Various publications and books about relays currently on the market can be divided into two groups. One is generally called "Low Power Relays" or "Power Relays" (both terms mean the same thing, i.e. a low power electromagnetic relay with a switching current not exceeding 30 A). The second group is "Protective Relaying" (protective relays for protection of power networks), where the emphasis is placed not on a description of the principles and construction of relays, but on schematic principles of protection of electrical networks and calculation of their operating modes.

On the one hand dividing the entire "world of electric relays" into two groups excludes some important relay implementations, for example relays with a switching current of hundreds of amperes, high-voltage relays, mercury relays, reed switch relays, solid-state relays, electric thermal relays, time-delay relays, safety relays and many others. On the other hand such an artificial division within the same field frequently results in separate treatment of common questions regarding relays which may be of different kinds, but are actually related and should be dealt with together and not separately. Experience accumulated for one type of relay is not always taken into account regarding other types of relays, even if the analogy is obvious. Moreover, modern protection relays usually contain

electromagnetic, reed switch or solid-state relays as output elements, and experts in relay protection must be aware of their idiosyncrasies. In addition, in many particularly powerful and high-voltage modern electronic systems (power supplies, powerful lasers, radars, etc.) experts face challenges of providing protection against emergency states (overload, overcurrent, etc.), similar to challenges encountered by specialists in relay protection.

Another disadvantage of current publications is that they rarely meet the full range of engineering requirements. Some are intended mainly for experts and are abundant in equations and calculations for relays; others emphasize standards, methods of quality control and other issues concerning production of relays; and still others for engineers and technicians who are not experts in relays but only use relays in their equipment. Most of these publications provide the information in such a simplified and limited way that they are of little practical benefit, as they do not give simple and understandable answers to many questions concerning the implementation of relays, such as the following:

- Is it possible to switch on an electric light bulb having a nominal current of 0,3A with the assistance of a reed switch relay with a nominal switching current of 1A? (The correct answer is NO!)
- Why does a relay, which has worked well for a year, begin to drone and to malfunction? (The reason is that the relay has been incorrectly installed with respect to the vertical line.)
- Why does the ground fault relay (“residual current device”) malfunction? Does it mean that the relay is out of order? (Not necessarily. Most often the reason is changes in insulation resistance of the equipment under exposure to moisture or high temperature.)

To answer these questions, it is essential to have a clear understanding of how relays function. That brings us to the question of what is necessary for effective study of the basic principles of relays of certain types? Is it enough just to analyze the specific construction of a certain relay? The author is convinced that it is not. The reason is that when a relay of a similar type but with a different construction is next encountered, the learning process must begin all over again.

For each type of relay, this book includes descriptions of several types of relay constructions, each functioning on a different basis. Moreover, you will find full coverage here of the historical development of relay construction – from the earliest to modern times. The author is convinced that only such an approach can ensure understanding of principles applicable of all types of relays.

The author aimed to write a comprehensive book about relays without the disadvantages of other books and publications listed above. This book covers the diversity of the “world of electric relays” and reveals the

dynamics of their development – from the earliest ideas to modern constructions and applications. In order to make the book understandable, not only for experts but also for laymen, the author utilizes the “picture-instead-of-formula” principle. Such an approach enables engineers, technicians, teachers and students who are interested in relay construction to use the book as an encyclopedia of electric relays.

Furthermore, general readers who are interested in the history of engineering will discover many interesting historical facts about the invention of relays. Inquisitive readers will be able to enrich their knowledge in the field of electronics by reading the chapters devoted to electronic relays.

It is for you to decide whether the author succeeded in attaining his objective.

This book consists of 16 chapters. The first four chapters cover the basic principles of relay construction and its major functional parts, such as contact systems, magnetic systems, etc. The following 12 chapters are devoted to various specific types of relays. Each of these chapters includes a description of the principles of relay functioning and construction as well as features of several different relays belonging to a certain type, but operating on different principles and developed at different times.

The information in the book is arranged such that the reader can work with any specific part without the having to refer to another part of the book. It is also structured to function as an encyclopedia of relays by facilitating consultation when the need arises. It helps the reader find answers to particular questions, and avoids the pitfall of forcing the reader to read the whole book even though certain parts may be of only marginal interest.

The author will be grateful for any suggestions and remarks aimed towards improvement of the book. Please send your comments to Publisher.

Vladimir Gurevich, Ph. D.

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