

Chapter 1 — Preface

The beauty of fireworks arises from their creation of organized patterns, mainly of fire, that consist of colors, lines and their movement and change in space and time. Chrysanthemum shells, also called ‘warimono’ (which means ‘hard-breaking shell’), produce uniquely beautiful effects by creating patterns resembling chrysanthemums on the background of the sky.

Until now, the design of chrysanthemum shells has been based entirely on the manufacturer’s experience and intuition. The purpose of this paper is to introduce a more scientific method, using experiments and calculations.

It must be noted that the requirements for a beautiful fireworks effect are not always strictly physical, but also sensual. For example, physics tells us that the trajectory of a star can never be completely straight. All that the artist requires, however, is that it should look straight.

The stars that produce light for fireworks effects are well developed, but the characteristics of the bursting charge are not as well understood. One of the important aims of this paper is to explain how to select the most appropriate bursting charge.

This paper is divided into seven chapters. Chapter 2 describes the basic facts about the construction of the chrysanthemum shell. Chapter 3 studies the problems of design. Chapter 4 discusses the preparation for experiments and necessary pre-calculations. Chapter 5 describes the experiments of burning the bursting charge in atmospheric air as a supplement to Chapter 4. Chapter 6 derives the formulas for the initial and traveling velocities of stars in the air. Chapter 7 prepares ballistic tables for moving stars and explains the relationships of the factors that affect the velocity of stars. Further, it describes the modification and safety aspects of the bursting charge. Chapter 8, using the formulas and ballistic tables, compares the experimental and calculated ballistics of stars.