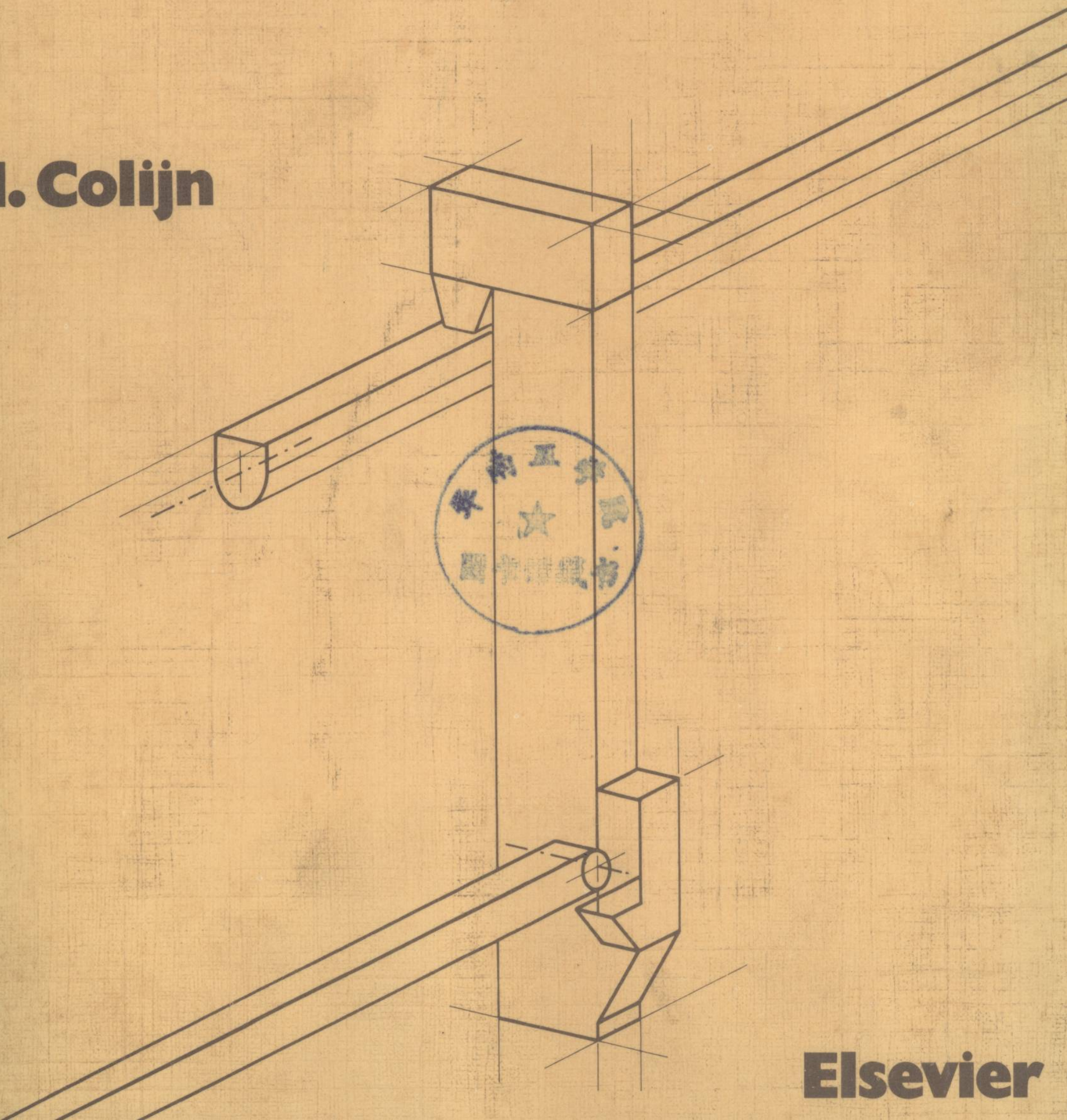


Studies in Mechanical Engineering 4

Mechanical Conveyors for Bulk Solids

H. Colijn



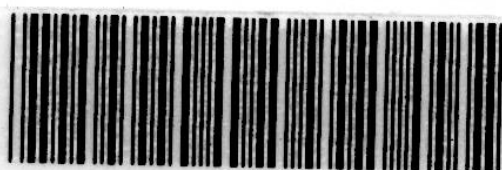
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Mechanical Conveyors for Bulk Solids

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STUDIES IN MECHANICAL ENGINEERING

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Foreword

The slaves who worked for Nero in the harbour of Rome were each able to manhandle 85 medimi of grain every hard working day. This is equivalent to 3.5 tons. Usually the grain was moved from the 450-ton kerkouros vessels and brought into the storehouses on the quay of the inner harbour of Rome, the Porto di Traiano. It is easy to believe that at the end of the day these slaves were very tired, perhaps exhausted. This was around the year 60 A.D.

When, by way of comparison, today's ship-unloader returns home at the end of the working day, he is not exhausted and may even be whistling and good-humored. Nevertheless, he has probably transshipped 8000 tons of grain that day from a 250,000 ton sea-going bulk carrier into one of the huge silos we have in our modern harbours. He has moved about 2300 times as much grain in a day as had that slave of Nero's time.

It is obvious that great progress has been made in the handling and storage of bulk granular materials. This progress has not, however, been gradual. Well over 90% of the development has occurred within the last 5% of the 2000-year period since the days of Nero.

In our modern world, vast quantities of bulk solids such as metal ores, coal, cement, grains, potash, limestone, sand, soya-beans and all their various by-products and derivatives are transported, handled, stored and processed every year. The variety of bulk solids to be handled in today's world is still increasing, especially with the tremendous growth of products in the chemical industry. This has resulted in a considerable number of technical problems for the efficient handling of these materials. These problems can range from the level of minor inconvenience to major stoppages, with resultant loss of production. Since large modern handling units are often integrated into huge overall systems, these stoppages and interruptions to production are often economically damaging.

In many ways it can be said that the Romans were better able to predict the performance characteristics of their handling- and storage-installations than we are in our modern world. However, this is not surprising in view of the increasingly complex behaviour of many of the bulk granular solids that are handled today.

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Thanks to intensified research and development in some 20 universities and institutions over the past two decades, most of the notorious silo problems can now be avoided by proper application of modern knowledge during the design phase. However, the same observation does not hold for the design of mechanical handling devices such as belt, screw, chain, vibratory, and elevating conveyors. Attempts have been made to improve this situation, but progress to date has been slow. Much of the more recently acquired knowledge is available only from widespread sources and is often hidden under the guise of proprietary information.

Thus it is pleasing to see an authority like Hendrik Colijn, whom I have known for many years, fill an existing knowledge gap with this book. It will not only serve experienced designers well but will be invaluable to young engineers for its updated overview of the field of mechanical conveying.

As Imperial units of measurement are still in use on the American continent, the author has retained these units for practical reasons. In order to serve the bulk solid engineers on a world wide basis, this matter has been discussed briefly at the beginning of the text which also contains handy conversions.

The well-known author has obviously expended considerable effort in producing this book, which will prove an indispensable reference for those dealing with the mechanical handling of bulk granular materials.

Borne, August 1984

Dr. F.J.C. Rademacher
Professor of Handling and
Storage of Bulk Solids,
University of Twente,
The Netherlands

Preface

The subject of "Mechanical Conveyors for Bulk Solids" is not well covered in the existing English book publications. Although each manufacturer in this field has an extensive supply of catalogs and sales and promotional literature available, a general, all-encompassing overview is not being provided.

A few publications have appeared in the past 50 years in the English language, but they are now out of date and out of print. Probably the largest selection of literature on this subject is available in the German language. Many German universities have extensive teaching and research programs relating to mechanical conveyors. However, for the English-speaking student and engineer, most of this information is lost because of language problems.

This publication is not intended to be a complete engineering or design manual of mechanical conveyors. The text consists mainly of my lecture notes used for teaching seminars and short courses in the USA and Canada. Therefore, the primary purpose of this publication is to provide a text for others who wish to teach this subject, and for students in technical colleges, or for industry seminars.

Because this text has been used up to now in North America, it is based on American practices, standards and units. I realize that many countries have slightly different standards or codes, and I would advise the readers in those countries to acquire that information as a supplement to this book.

H. COLIJN

Acknowledgements

I want to express my appreciation to the Conveyor Equipment Manufacturers Association (Washington, D.C.) and the Goodyear Tire & Rubber Company for allowing me to use sections from their publications in this book. Sections from "Belt Conveyors for Bulk Materials" by the Conveyor Equipment Manufacturers Association, copyright 1968 and 1979, have been reproduced by permission of Van Nostrand Reinhold Co. Inc.

Also, much information has been obtained from manufacturer's sales and promotional literature published during the past 30 years and it would be impossible to provide specific credits to each company. I thank the industry as a group for the use of any of their data or information used in this book.

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Chapter I

General Comments on Mechanical Conveyors

1.1.0. Introduction

Material handling plays an important part in the industrial economy. Mass production depends primarily on conveying systems, and expansions in mass production invariably follow improvements in methods of handling the materials involved. Conveyors have become so completely a part of the industrial economy, that it is literally true that conveying equipment is used in the production and distribution of everything we eat, drink, wear, live in, ride in, or in which we take pleasure - from the mine or the farm - through the factory or processing plant - through warehousing and distribution - and ending only with the ultimate user.

Mechanical conveyors are an essential part of mechanized handling in the industry, either for bulk materials or for packaged goods. Selection of mechanical conveyors is often left to the vendor, because the user or purchaser does not have sufficient background or knowledge on this subject. Although the assistance of equipment manufacturers in this field is very valuable, the user should basically make his own selection based on his process or plant requirements. To assist students, engineers and operators in the industry in the selection, application and design of mechanical conveyors for bulk materials, this text will cover a variety of topics concerning mechanical conveying systems.

Under "conveyors" we may classify all fixed and portable equipment for conveying materials between two fixed points with continuous or intermittent forward movement, but with a continuous drive. The American Conveyor Equipment Manufacturer's Association (CEMA) defines about 80 types of conveyors, 10 types of elevators and 50 types of feeders. It would be impossible to cover each one in this publication. We have therefore selected a few of the most common types of mechanical conveyors and elevators for bulk materials and some of the associated equipment.