money would you need to put your plant in first class condition? How much are you planning to spend for new plant and equipment? Where do you expect to raise the money? The results will be reported later in this editorial series. Already the survey shows we have fallen many billions of dollars behind.

Some shortcomings are apparent to everyone. They are revealed in a lot of rickety transportation facilities and in rundown buildings.

Many other deficiencies do not come into general view. They are, for example, the antiquated machines in our plants. Of the privately-owned machine tools in use in 1945—when the last census of metalworking equipment was made by AMERICAN MACHINIST—54% were more than 10 years old. Their average age is higher today.

It is true that in recent years we have hit new highs in total national production. But we have done so by putting far more people to work than ever worked before . . . and by driving equipment to the limit of its waning endurance, sometimes beyond. It has not been done *primarily* in what is by all odds the best way to increase production—to use more and better and more modern tools and equipment.

Haven't we overcome much of this twenty-year deficit by rushing to build new plants since the end of the war?

No. For two clear-cut reasons:

1. The accumulated shortage is tremendous. The total of about $40 billion, which has been spent for industrial plant and equipment since VJ-Day, has not wiped it out.

2. Some key industries have had difficulty in getting the facilities they need. Take steel, for example—the industry that turns out our most basic industrial material. Its needs for new equipment are measured in billions of dollars. To pay for that equipment, it should have *risk capital*—money which people are willing to invest with a risk of losing for the sake of gain. For steel is an up-and-down industry. Earnings on its common stocks inevitably share both ways in those ups-and-downs.

Since the war, steel, in common with most industry, has been unable to market new common stock successfully. Its outstanding stock is now selling for only about one-half the current worth of the industry's present assets. With investors willing to pay only 50 cents on the dollar for its facilities, the industry can not readily sell stock to pay for *new* plant and equipment at higher prices even than the old.

Why can't steel—and other industries—attract people who are willing to risk their money retooling America?

The full answer to that serious question must be left to future editorials in this series, for it involves many things . . . tax reform . . . mobilization of small savings . . . a new respect for corporate profits.

This first editorial seeks simply to emphasize two fundamentals:

First, our standard of living improves with the *quality* of our industrial equipment.

Second, American industry and American workmen badly need billions of dollars worth of better equipment *now*.

The American people must understand that not *only our continued prosperity but also our security as a nation depends upon giving American industry more and better equipment.*

"Give us the tools." This was Winston Churchill's cry for help to win the war. Only if we give American industry new and better tools will we have a chance to win abiding prosperity at home and good order abroad.

James H. McGraw, Jr.

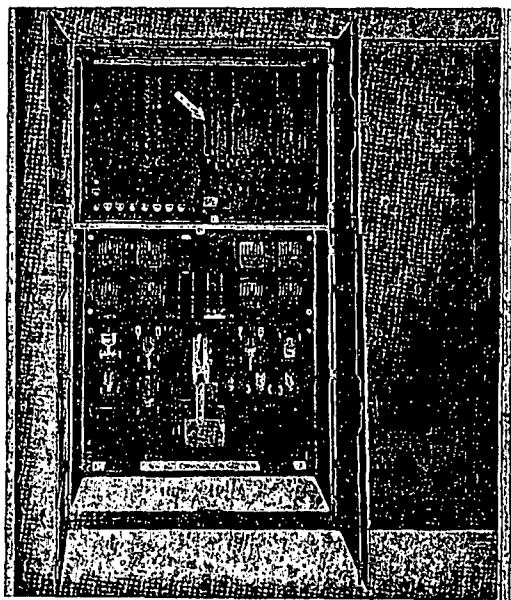
President, McGraw-Hill Publishing Company, Inc.

★ THIS EDITORIAL, and a series to follow, will be devoted to a single problem—how to provide American industry with the equipment needed to improve, that envy of the world, the American standard of living. No more important problem confronts us today. Upon our wisdom in handling it depends not only the degree of our prosperity, but also our security as a nation.

THIS IS THE 69TH OF A SERIES



1 Control panel for sectional paper machine with amplidyne exciters located beneath a row of electronic regulators



2 Arrow points to thyratrons used for excitation of motor and generator fields; electronic speed regulator to left

Electronic Control for DC Motors

Exact speed and current-limit control of dc motors is one use for amplidyne generator or thyratron exciter, coupled with an electronic regulator

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INTRODUCTION OF ELECTRONICS to the power field has meant much in today's advancement in industrial control. Used with electronic tubes, *thyratron* rectifiers and the *amplidyne* generator are finding wide application in controlling speed of dc shunt motors in industrial drives. A thyratron tube is simply a gas-filled rectifier tube with grid control. An amplidyne (amplifying dynamo) is a unique, separately excited dc generator usually driven by a squirrel-cage motor.

There are three common ways to vary speed of a dc shunt motor: (1) changing value of resistance in series with shunt field (2) varying armature voltage while keeping field strength constant (3) combining both methods in a system utilizing armature and field control. For the moment let us consider No. 2, variation of armature voltage. With this method it is customary to get armature-voltage variation by changing field strength of a separate generator used to feed armature of the driving motor. This system, which requires control equipment on a low power level, offers a large degree of flexibility as well as a wide speed range.

In systems explained in this article, the general aim is to establish desired speed for the driving dc shunt motor and maintain that speed over a wide load range. In such closed-cycle control systems, a *standard* is established that determines the speed to maintain. Against this standard is balanced an electrical impulse that indicates actual speed of drive. Any deviation of actual speed signal from the standard starts corrective action to reduce speed differential.

Speed-Control Needs. The following speed-control systems, singly or in combination, are widely used on industrial drives.

1. Regulation of speed under load. Operator sets manually the desired speed level, which may be adjusted over a wide range. Regardless of changes in load this speed is maintained with small error, often as low as one half of one percent of full-load speed.

2. Program control of speed. Speed setter, which determines the standard, may be varied by automatic means, either as a cyclic function, or as a function of the manufacturing process such as tension of strip being reeled.

3. Current-limit control. During acceleration and deceleration, armature current must not exceed commutating limit. It is customary to superimpose