PRACTICAL HEAT

PART II

TERRELL CROFT, Editor

CONSULTING ENGINEER. DIRECTING ENGINEER, TERRELL CROFT ENGINEERING CO.
MEMBER OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
MEMBER OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
MEMBER OF THE AMERICAN SOCIETY FOR TESTING MATERIALS.
MEMBER OF THE ILLUMINATING ENGINEERING SOCIETY.

First Edition
Sixth Impression

McGRAW-HILL BOOK COMPANY, Inc.
NEW YORK: 370 SEVENTH AVENUE
LONDON: 6 & 8 BOUVERIE ST., E. C. 4

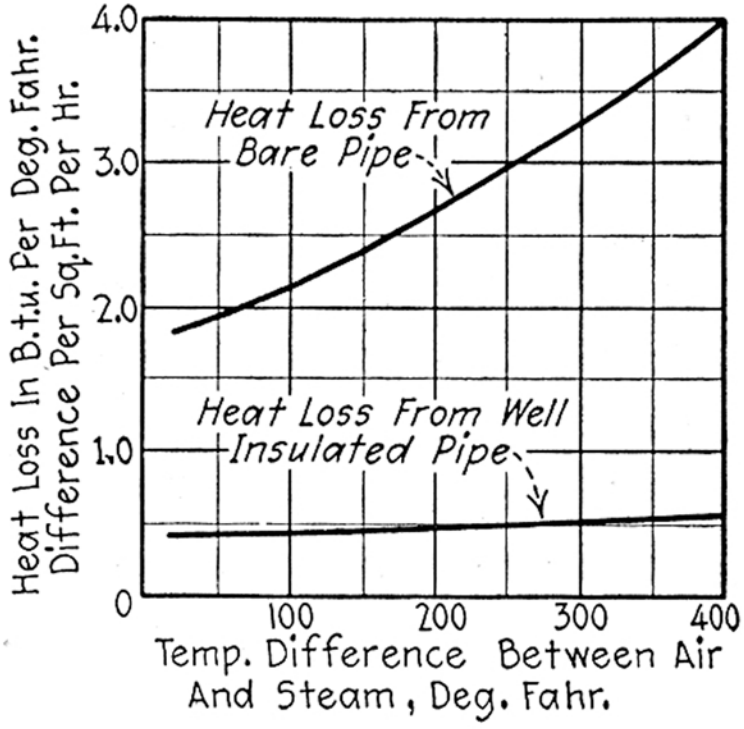

Fig. 425.—Heat loss from steam pipes.

DIVISION 15

STEAM POWER PLANTS

495. The Function Of A Steam Power Plant (Fig. 423) is to convert into mechanical work the chemical energy (Sec. 28) which nature has stored in the fuel. In performing this function, the chemical energy—or a part of it, at least—which is contained in the fuel and in the oxygen of the air, is in the boiler furnace, transformed into and given up as heat energy, by combustion (Div. 14). Much of the heat energy thus liberated, is transferred to water in the boiler; this heat added to the water vaporizes the water into steam, in which most of the heat remains stored for transmission. This heat stored in the steam is then transmitted in pipes to some mechanical device (engine) which is so designed that a part of the heat energy in the steam is by the heat enigne transformed into mechanical work.

NOTE.—THE PURPOSE OF THIS DIVISION is to describe briefly the fundamental function and the operation of some of the more essential components of the modern steam power plant. For a more detailed treatment of these various elements, the reader is referred to the following books by the author: "Steam Boilers," "Steam-engine Principles And Practice," "Steam-turbine Principles And Practice" and "Steam Power Plant Auxiliaries And Accessories."

496. The Essential Parts Of A Steam Power Plant (Fig. 423) are: (1) *The boiler furnace, F.* (2) *The boiler, B.* (3) *The steam piping, P.* (4) *The prime mover, E.* The functions of each of these parts are described in the notes below and the parts themselves are further discussed in following sections.

NOTE.—THE BOILER FURNACE AND THE BOILER are frequently so constructed that a definite and rigid distinction cannot always be made as to just what part constitutes the boiler and what part constitutes the furnace. *The boiler furnace* (*F*, Fig. 423) generally consists of some device, such as a grate (under *F* in Fig. 423) or burner (Fig. 429) for

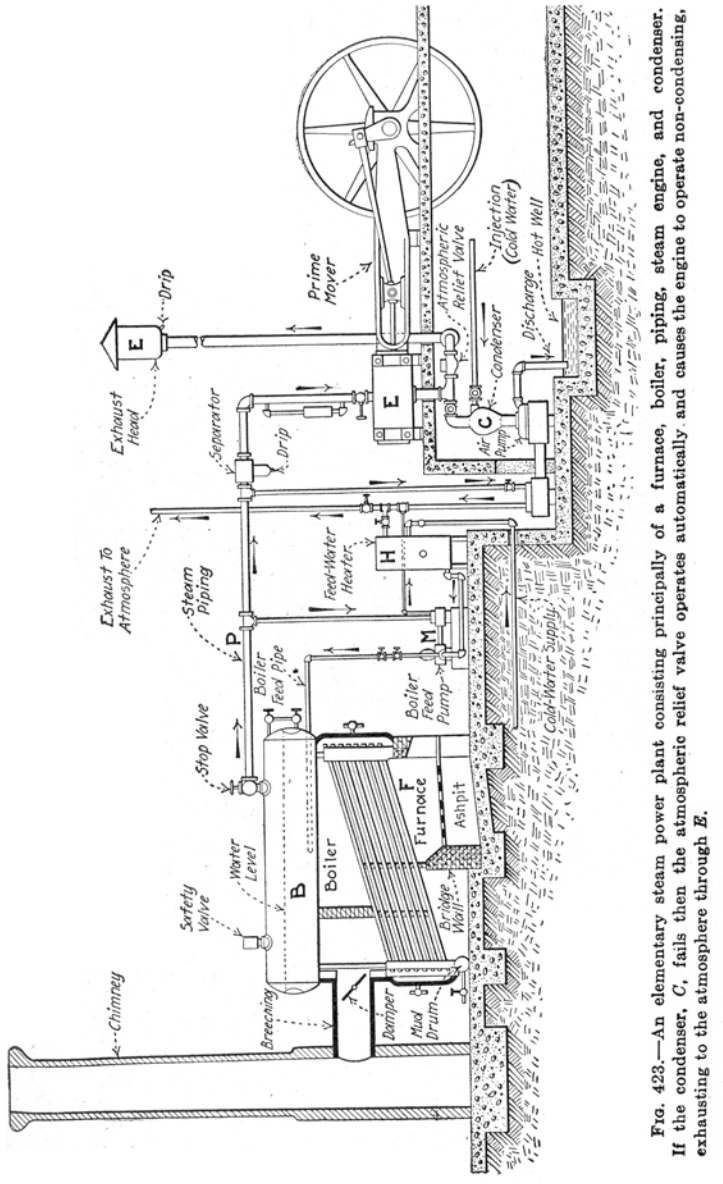

FIG. 423.—An elementary steam power plant consisting principally of a furnace, boiler, piping, steam engine, and condenser. If the condenser, *C*, fails then the atmospheric relief valve operates automatically and causes the engine to operate non-condensing, exhausting to the atmosphere through *E*.

bringing the air which is necessary for combustion (Sec. 472) into intimate contact with the fuel, and a space, or *combustion chamber*, usually enclosed by firebrick or metal, wherein the combustion is completed and the hot products of combustion (Sec. 463) transmit a part of the heat which they contain to the boiler. The *boiler* is a closed vessel in which, by the absorption of the heat of combustion of the fuel, water is boiled and thereby converted into steam. The heat of combustion of the fuel is transmitted to the walls of the boiler by radiation (Sec. 138), con-

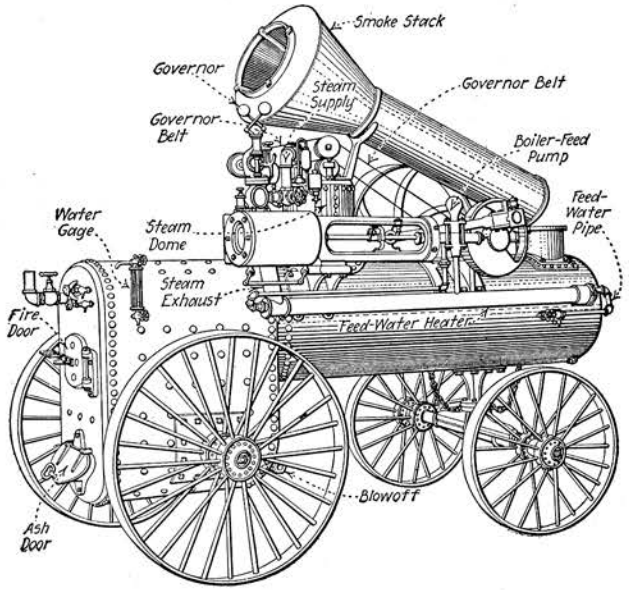

Fig. 424.—A complete portable non-condensing steam power plant. A self-contained hoisting-engine-and-boiler outfit is another example of a complete portable steam power plant.

duction (Sec. 111) and convection (Sec. 137). The heat is transmitted by conduction through the walls of the boiler to the water which is contained within the boiler. By the addition of a sufficient quantity of heat to the water, it is caused to boil (Sec. 313) and form steam. Thus, a part of the chemical energy in the fuel is transformed into heat energy and stored up in the steam as such. Practically any liquid could be used in the boiler as the storage and transmitting medium for the heat energy. However, due to the almost unlimited supply of it and also to certain of its inherent characteristics, water—or water vapor which is steam—is, where the combustion of the fuel does not occur within the engine cylinder, always used as the medium in which the heat of com-

bustion is stored for transmission from the furnace to the prime mover. See Sec. 391 for the reasons why water is the best medium for this purpose.

Note.—The Function Of The Steam Piping (*P*, Fig. 423) is to conduct the heat in the steam from the boiler to the prime mover. If the prime mover is mounted on the boiler (as it is in the locomobile and in portable power plants, Fig. 424, of certain types), the steam piping can be omitted. However, practical considerations generally prohibit such an arrangement for plants of medium or large capacity. The pipes which conduct the steam from the boiler to the prime mover are generally covered with some heat insulating material which offers great resistance (Sec. 114) to heat flow. Thus, the loss of heat from the steam, between the boiler and the prime mover, is minimized; see Fig. 425.

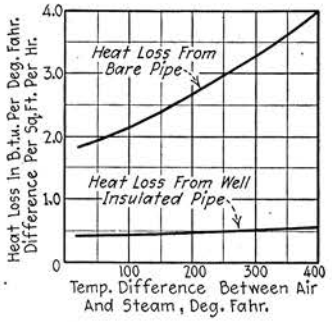

Fig. 425.—Heat loss from steam pipes.

Note.—The Function Of The Prime Mover Of A Steam Power Plant is to convert into mechanical work the maximum possible amount of the heat energy which is delivered to it in the steam. The prime mover in a steam power plant is either a reciprocating steam engine (Sec. 502) or a steam turbine (Sec. 505). The engine or turbine drives mechanically an electric generator, a line shaft, or some other device which will transmit energy or useful work.

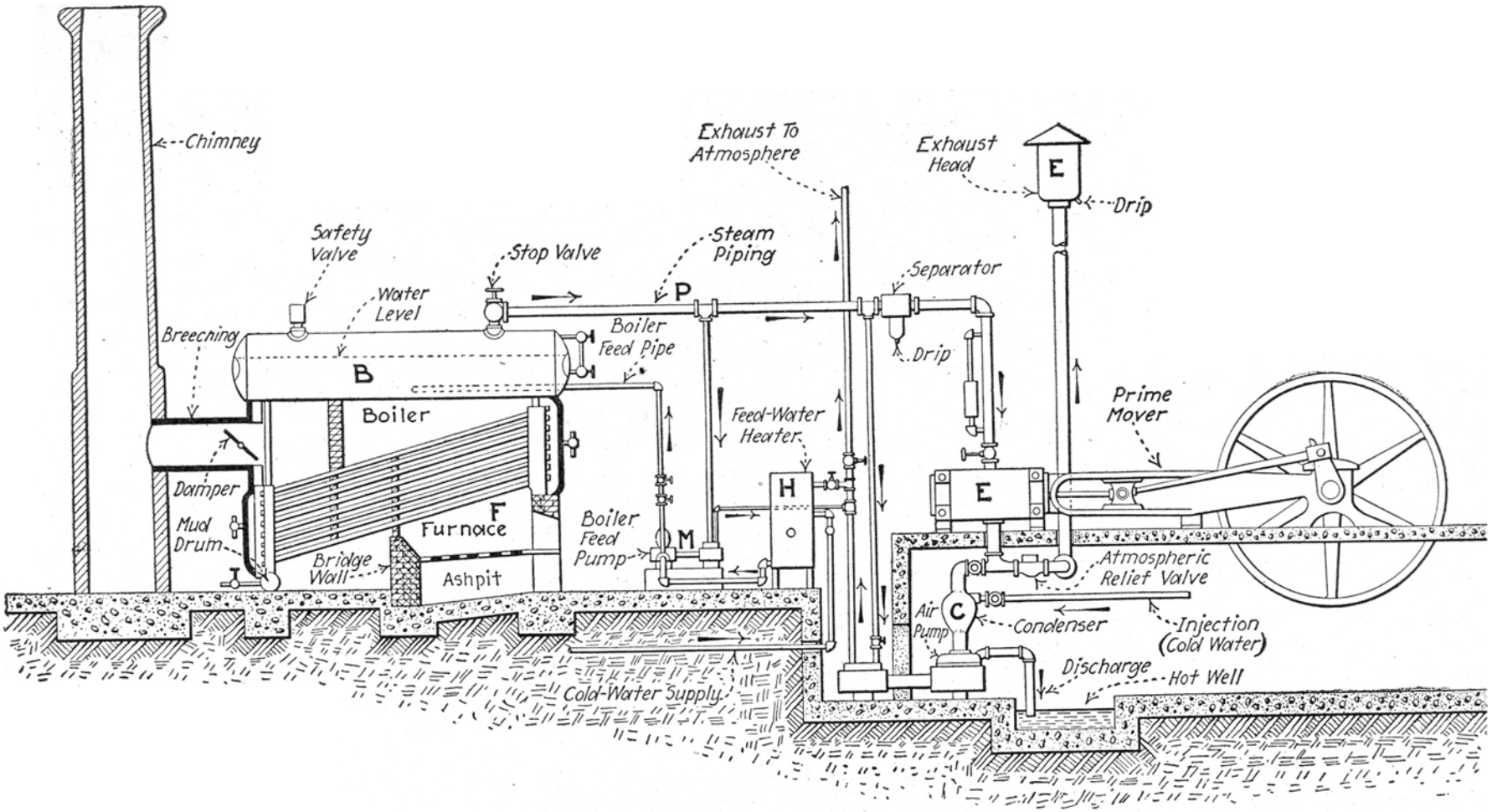

FIG. 423.—An elementary steam power plant consisting principally of a furnace, boiler, piping, steam engine, and condenser. If the condenser, *C*, fails then the atmospheric relief valve operates automatically and causes the engine to operate non-condensing, exhausting to the atmosphere through *E*.

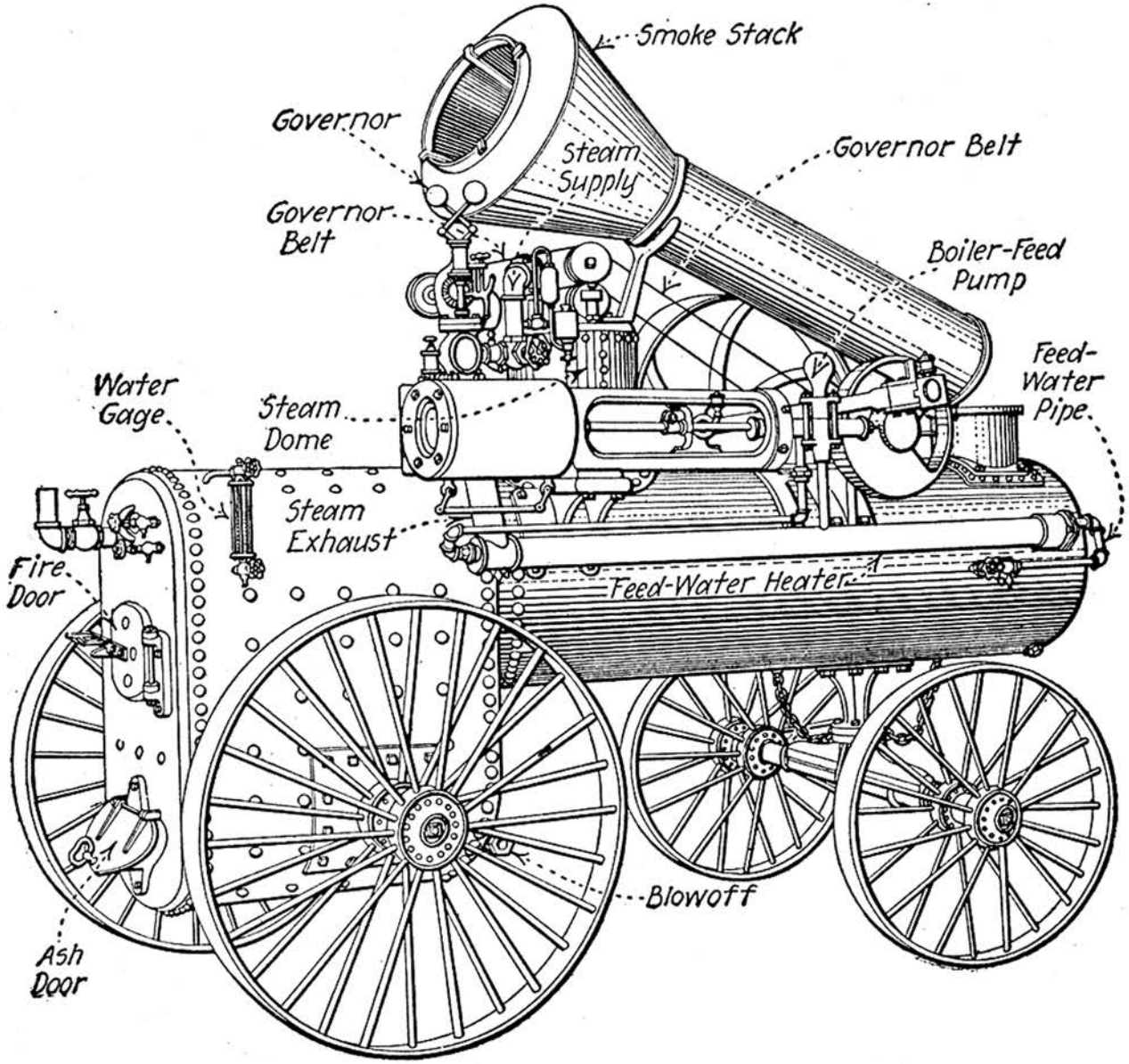

FIG. 424.—A complete portable non-condensing steam power plant. A self-contained hoisting-engine-and-boiler outfit is another example of a complete portable steam power plant.