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## CROSS-INDEX OF SUBJECTS FOR THE MONTH

**MAY 1950 • VOL 94 • NO. 5**

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**STEAM GENERATION, FUELS, FIRING AND COMBUSTION**
**TURBINES, ENGINES, AUXILIARIES; HYDRO POWER**
**DIESELS, GAS ENGINES AND ACCESSORIES**
**AIR CONDITIONING AND REFRIGERATION**
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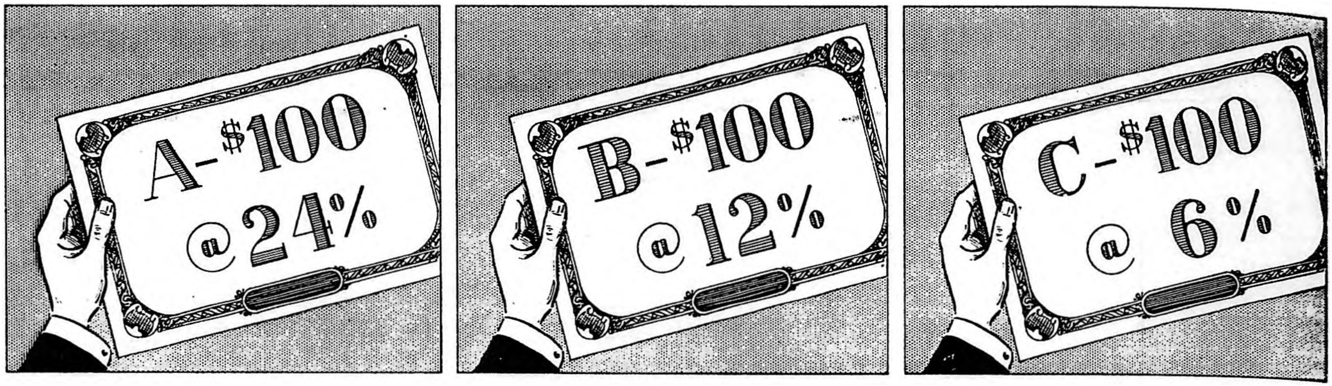
**INSTRUMENTS, CONTROLS**
**PUMPS, COMPRESSORS**



Cover photo taken in feed-pump area of recently expanded boiler house at Cities Service Co's East Chicago refinery. Courtesy of M W Kellogg Co, who handled the refinery modernization, including new boiler and renovation of feedwater system


James H McGraw (1860-1948), Founder; Curtis W. McGraw, President; Willard Chevalier, Executive Vice-President; Joseph A Gerardi, Secretary and Treasurer; Paul Montgomery, Senior Vice-President, Publications Division; Nelson Bond, Vice-President and Director of Advertising; J E Blackburn Jr, Vice-President and Director of Circulation ● DISTRICT MANAGERS; New York, W W Quarles; Philadelphia, C R Long; Cleveland, N O Wynkoop Jr; Chicago, C Boughton, J L King; Boston, J E Slater; St. Louis, C Boughton ● PUBLICATION OFFICE: 418 West 25th St, New York 1, N. Y. ● EDITORIAL AND EXECUTIVE OFFICE, 330 W 42nd St, New York 18 N Y ● Cable Address: "McGraw-Hill New York ● DISTRICT OFFICES: 520 N. Michigan Ave., CHICAGO 11; 8 Post St, San Francisco; National Press Bldg, Washington 4; Architects Bldg, Philadelphia 3; 738-9 Oliver Bldg, Pittsburgh 22; 1510 Hanna Bldg, Cleveland 15; 2980 Penobscot Bldg, Detroit 26; Continental Bldg, St. Louis 8; 1427 Statler Bldg, Boston 16; 1011 Rhodes-Haverty Bldg, Atlanta 3; Pacific Finance Bldg, Los Angeles 14; Aldwych House, Aldwych London WC2 ● POWER articles are indexed in both the Industrial Arts and the Engineering Index ● POWER issues its own index annually; copies are available on request to the editorial offices, 330 W 42nd St, New York 18.

IF YOU COULD BUY ONE OR MORE OF THESE BONDS, WHICH WOULD




## Insulation Handbook: Part 3

# Which Thickness Pays Best?

**Editor Phil Swain tells why the thinnest insulation generally pays out the fastest, yet is rarely the best investment. Future chapters will tell more about heat and dollar savings—also, how to select and apply the various insulating materials**

► HOW THICK SHOULD heat insulation be? The thicker the insulation, the more heat saved. But how do you figure how much is enough?

It's important to think straight on this matter before plunging into a lot of practical details, so this brief article will concentrate on the reasoning. After the logic is clear, the practical application will be easy.

As an investment, heat insulation differs from security investment in several respects. First, when you apply a reasonable thickness of insulation to a heated surface you often get a yearly return of more than 100% on your money—and with all the safety of Government bonds.

Yet few of us will become millionaires by this kind of investment because the amount we can invest is always limited by the area of the existing bare heated surfaces in our plants.

Nor can we get rich by building up the insulation thickness indefinitely. Heat and dollar loss from the bare surface puts an absolute ceiling on the possible savings by any conceivable thickness of insulation. The first inch or two plugs most of this bare-surface loss. All subsequent inches can do is to save part of what would escape from the under layers alone.

This line of thought leads directly to the standard method of finding the so-called "economic thickness"—the thickness that is the wisest investment. Strange to say, this is not the same as the thickness that yields the highest percentage return on the total dollars invested. In fact the thinnest available commercial thickness generally yields the highest percentage return, yet is rarely the best investment.

**Like Buying Bonds.** To clear up this puzzle let's think through a parallel case in an imaginary investment market. Suppose some very good friend should offer to sell you the unusual bonds pictured at the top of this page. He will let you buy any you wish for $100 each, but only one of each.

Let's assume, in this imaginary case, that the safety of both interest and principal is beyond question.

Naturally you reach first for bond *A*. In this deal you make no mistake. You will get $24 per year for your $100, and that's 24%.

Nor do you hesitate about buying bond *B*, which is good for 12% per year, on your second $100.

Unless you are hard pressed for cash, you will probably find bond *C*, paying 6%, also worth while. We shall assume that you are not interested in getting 3% on bond *D*. So, for $300 you buy a yearly yield of 24 + 12 + 6 = $42 = 14%.

Now certainly every move you have made has shown sound business judgment. Yet when you added bond *B* to bond *A* you cut your percentage return on your total investment from 24% to 18%. Adding *C* reduced it to 14%.

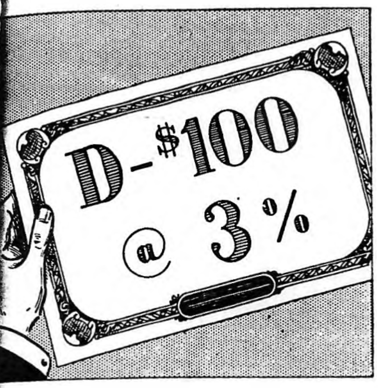
**Highest Return, Wisest Buy.** So here you have a strange situation where an 18% return is more "profitable" than a 24% return, and a 14% return more profitable than an 18% return.

What you have done is to assume a series of small limited investments arranged in decreasing order of attractiveness. You start at the head of the list and work down, taking each in turn until you reach one that ceases to attract. Then you stop. You have made the wisest total use of your money, yet you are surely getting a smaller percentage return on your investment than if you had stopped with the most favorable investment item offered.

**Figuring Economic Thickness.** Now this imaginary bond-buying setup exactly parallels what an engineer, skilled in heat-insulation economics, does when he selects the "economic thickness" of insulation for a given set of conditions.

He considers the various thicknesses commercially available and figures for each the total yearly heat loss in dollars. His first (and best) investment is the first thin layer applied to the bare surface. Next he figures how much more

## U SELECT? ...... THAT'S HOW YOU DECIDE THE THICKNESS OF HEAT INSULATION




**A** ........................ **Yields 24%** ◄ **This is good.**

**A + B** ........................ **Yields 18%** ◄ **This is better.**

**A + B + C** ........................ **Yields 14%** ◄ **This is still better.**

**A + B + C + D** ........................ **Yields 11%** ◄ **Not so good.**

he next thickness costs and how much more it will save. If this *additional* saving is an adequate return on the *additional* investment, he decides to go that far.

Then he treats the next possible step in the same way—and so on until he reaches the point where the game is no longer worth the candle, the point where any further increase in thickness doesn't yield a reasonable return. That is the proper stopping point, the economic thickness.

**Stacking Up Sheets.** Now let's work this out for an idealized case where the insulation is available in flat sheets 1 in. thick and costing $1.00 each. Assume that these can be stacked up on a level heated surface without any installation cost.

Assume, also, that heat losses (in dollars) are as indicated in Table I for the area covered by the sheets.

Here the first layer is truly a wonderful investment, paying 150% yearly. With the first layer on, however, there is no further opportunity for such a killing, but the 22% return on a second layer is still attractive. Usually the owner will also be interested in the 9% return on the third layer, but probably not in the 5% on the fourth.

Here, then, the economic thickness (the best all-around investment) is the 3-in.

Yet, as shown in column 5 of Table I, the percent return on the total investment is 150% for 1-in., 86% for 2-in. and 60% for 3-in. Here, as with the bonds, the minimum investment is not the best investment, although it yields the highest percentage return.

**Practical Example.** Turning from this simplified case to an actual situation, we note several differences. First, the greater thickness considered may not be obtained by adding layers, but by substituting thicker layers. Yet the same logic holds here. We merely consider the *difference* in cost and the *difference* in yearly saving for each step in thickness.

Again, in our simple illustration, we neglected the cost of application. We also assumed that each layer cost the same as every other. Obviously the *applied* cost of 2-in.-thick insulation will be less than double that for 1-in.

Table II gets down to a practical case. Columns 2 and 3 show, respectively, actual contract prices for a complete job (insulation of a heater) and actual yearly heat losses in dollars. Note that the half-inch increment from 2½ in. to 3 in. pays 13% while that from 3 to 3½ pays 9%, indicating that either 3-in. or 3½-in. total thickness would be reasonable.

Most plants would not consider the 5% return for the next increment worth while, so would stop with 3½-in. thickness. In any given case the choice will depend on the ease of getting investment money, other possible uses for the available cash, the stability of the business, and other local factors.

Later chapters of this handbook will show how to figure losses for various thicknesses and how to determine the economic thickness of heat insulation for specific conditions.

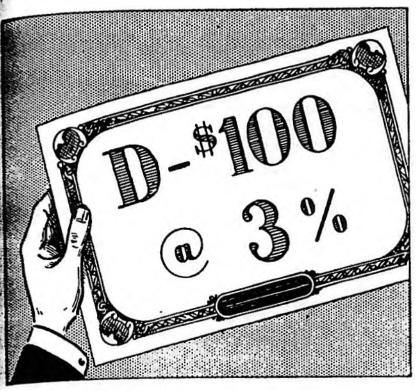
### I: EFFECT OF STACKING UP LAYERS 1 INCH THICK

| No. of layers | Total investment, $ | Total yearly loss, $ | Total yearly saving, $ | % return on total investment | Investment in last layer, $ | Yearly savings, last layer, $ | % return, last layer |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 2.00 | — | — | — | — | — |
| 1 | 1.00 | 0.50 | 1.50 | 150 | 1.00 | 1.50 | 150 |
| 2 | 2.00 | 0.28 | 1.72 | 86 | 1.00 | 0.22 | 22 |
| 3 | 3.00 | 0.19 | 1.81 | 60 | 1.00 | 0.09 | 9 |
| 4 | 4.00 | 0.14 | 1.86 | 46 | 1.00 | 0.05 | 5 |

### II: BID ANALYSIS FOR INSULATING HEATER

| Thickness, in. | Total cost installed, $ | Total yearly heat loss, $ | Cost of increment of thickness, $ | Yearly saving from increment $ | % |
|---|---|---|---|---|---|
| 0 | 0 | 360 | — | — | — |
| 1 | 200 | 90 | 200 | 270 | 135 |
| 1½ | 260 | 63 | 60 | 27 | 45 |
| 2 | 318 | 48 | 58 | 15 | 26 |
| 2½ | 374 | 38 | 56 | 10 | 18 |
| 3 | 429 | 31 | 55 | 7 | 13 |
| 3½ | 484 | 26 | 55 | 5 | 9 |
| 4 | 539 | 23 | 55 | 3 | 5 |

# YOU SELECT? ...... THAT'S HOW YOU DECIDE THE THICKNESS OF HEAT INSULATION

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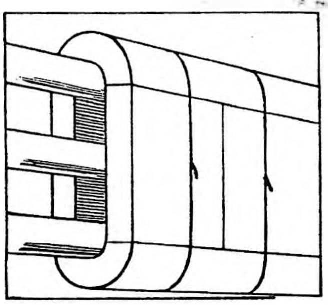
# What's wrong with this picture?

This man is insulating these exposed water tubes the hard way. He's covering each tube separately, instead of insulating the group as a single unit. When boiler tubes, or any other group of hot lines, operate at the same temperatures and are as close together as these, it takes less time and less material to insulate them as one unit. This method is shown in the small illustration below. It also cuts down the area of exposed insulation surface, thus reducing the amount of heat lost by radiation.

Half sections of pipe covering are used on the outside lines, then all lines are boxed in together with insulating block. Of course, if the lines are spaced too far apart, or if they must be readily accessible for maintenance, each line should be insulated separately.



Sometimes whether to insulate piping singly or as a unit may be a pretty close decision. At other times, the answer may be obvious. But there is always one best way of doing this job, just as there is for every other phase of heat insulation work.

In cases like this, Armstrong engineers are trained to recommend the least expensive and most efficient methods. The complete contracting service they represent also supplies you with top-quality insulation materials and sundries, applied by skilled Armstrong installation crews.

If you consult an Armstrong engineer the next time you plan a heat insulation job, his advice may save you time and money. His services are always available without obligation. Call the Armstrong office nearest you or write to Armstrong Cork Company, 7005 Maple Ave., Lancaster, Pa.

## ARMSTRONG'S INDUSTRIAL INSULATIONS

**MATERIALS - INSTALLATION**

**FOR ALL TEMPERATURES FROM 300°F. BELOW ZERO TO 2800°F.**