has converted the science of the laboratory into the art of the factory.

I will confine my remarks to one particular line in which I have, for some time past, been accumulating experience of more or less value. The enormous increase of mining and other operations has resulted in a much increased demand for dynamite, which, in its turn, has much increased the demand for glycerine, which, as you know, is the all important constituent of nitro-glycerine. Glycerine is produced from the animal and vegetable fats and oils which contain from 5 to 11 per cent. This is the source of all the glycerine produced, and it comes by way of the soap industry almost entirely.

It may not be uninteresting to know that fats and oils are definite chemical compounds of fatty acids with glycerine, and in the manufacture of soap the soda used seizes the fat acids forming a soda compound with them, and, at the same time, expelling the glycerine, which is subsequently found in the spent lye. Only a few years ago these spent lyes—which were a long way from being spent—were discharged into the sewers, carrying with them a valuable freight of soda, salt, and glycerine. This is now all changed and no modern soap factory is without its chemist and glycerine plant. After the lyes have been purified and filtered through presses, they are evaporated in an apparatus of considerable size, as large volumes must be handled, the one essential of successful operation being a high vacuum of great steadiness.

At this point we reach the crucial difference between vacuum pan-practice and condensing engine practice. The engine uses and passes on to the condenser a definite volume of steam varying only as the load on the engine, and in direct relation thereto. Should the vacuity increase, the steam can come no faster than it is permitted by the opening of the exhaust valves. But, on the other hand, the higher the vacuum the less will be the steam consumption, because the mean effective will be increased by the increase of the vacuum. So vacuity in engine practice is important only as an economizer, but it is otherwise in the glycerine plant. Here it is as though the condenser is hitched up to a low pressure boiler, for we have a large steam drum continually pouring heat into the liquor in the machine and the vacuum must be kept uniformly high to avoid loss. To emphasize this point, let us suppose that we have 10,000 lbs. liquor in our evaporator, and we are running on a low vacuum of, say, 24″ corresponding to a boiling point of 141 deg. F., and for some reason, such as cooler injection or perhaps a lower steam pressure in the steam drums our vacuum rises to 28″ corresponding to a boiling point of 109 deg. F. We have a difference of 109 to 141, equal to 32 deg. F. in the boiling point. Now, 1 deg. F. per lb. is equal to 1 B.T.U., but we have a difference of 32 deg. F. in each pound, which amounts to 32 x 10,000 = 320,000 B.T.U. suddenly set free. But a compensating occurrence mends matters somewhat, viz., that at 28″ vacuum the latent heat of vaporization is 1043 units, as against 1015 units at 24″ a difference of 28 B.T.U. This multiplied by our 10,000 lbs. would use up 280,000 of our 320,000 thermal units, leaving a balance of 40,000 units of superheat which is suddenly used up in vaporizing the liquor.

Now 40,000 thermal units will vaporize 40 lbs. of liquid boiling at 28″, each pound of which vapor will occupy 334 cubic feet at 28″ vacuum, and 334 x 40 = 13,360 cubic feet. Of course, this sudden generation of vapor so lowers the degree of vacuity, in consequence of which the B.P. rises; but the vacuum again tending to rise brings down the boiling point again with the consequent evolution of large volumes of vapor. The consequence is that large fluctuation and loss ensues. These remarks apply precisely to steam generation in boilers; for suppose we have a boiler at 100 lbs. gauge pressure you have nominally 115 lbs. absolute pressure, whereas at 28″ so-called vacuum you have about 1 lb. absolute pressure. The sudden generation of vapor, consequent upon the sudden rise in vacuity, is the exact counterpart at different pressure of that class of priming in boilers brought about by a suddenly increased demand for steam; for vacuum is only another name for pressure so low that it is less than that which the atmosphere imposes upon us. If steam rises faster than 2 to 3 ft. per second from water, it will carry spray. It would result in making matters much more easy and less ambiguous for engineers were all pressure gauges to read from absolute pressure. We have in the Fahrenheit thermometer a similar misnomer in the zero and below zero degrees, which arose from the ignorance prevailing at the time this thermometer was constructed. We know to-day, and frequently record the fact, that Fahrenheit's zero is not zero—or point of no heat—when we register degrees below zero; and we have in physics also an absolute zero, or, as we would say, 488 deg. F. below zero.

In order to become warned in time of the disastrous fluctuations of vacuity, the author has devised a special gauge and alarm (described elsewhere in this issue), which has resulted in the saving of much valuable material.

In practice our spring gauges show how many inches of vacuum we realize, but they give us no idea of what per cent. of vacuity is reached. For instance, 26″ vacuum on the gauge would represent 92.8 per cent. of vacuity on a day when the barometer read 28″, but the same gauge reading on a day when the barometer read 29.7 would be only 87.6 per cent. With the object of having an instrument which would infallibly show how far short of perfect vacuity we come, another little device was arranged which has also been of inestimable advantage. A glass tube of about 3-16-in. internal diameter was sealed at one end and bent into the form of a close U, the open end being longer than the closed end. This tube was nearly filled, very hot (to avoid the presence of any moisture), with mercury. When erected, the mercury filled the closed leg, the bend, and about 1-in. of the open leg. On connecting this tube with the exhausted apparatus, the mercury will descend in the closed leg and will, of course, rise correspondingly in the open leg, till the level of the mercury in the two legs differs by an amount exactly equal to the difference between the vacuum realized and absolute vacuity (neglecting, of course, the loss due to the vapor tension of mercury which at ordinary temperatures is infinitesimal).

Some few points in regard to pumps and joints may be of practical interest, as coming from practical experiences. In an evaporating glycerine plant there are necessarily many large joints and an almost bewildering number of valves from ¼-in. to 10-in. diameter. On our joints we invariably lavish a generous supply of "asphalt paint," which will stand exhaust steam heat and is immune to the action of acids and alkali, and will allow when warm of the thickened masses being sucked into leaks successfully stopping them if not too large, but, very large leaks may be stopped by adding dry red lead to the paint.

In regard to pump valves, the lighter the better, commensurate with sufficient strength, and in regard to springs I have discarded them entirely on the suction at times and have benefited thereby. In operating stills where the dry vaccum pumps are used only enough water passes to seal the valves, and it is well that they be slung on the underneath of the suction valve plate, the springs being only just strong enough to raise them to their seat. The great importance of a high vacuum on glycerine stills has led to the connecting of a second pump to the discharge of the first. It is manifest that on the dry vacuum pump there must always be sufficient atmosphere of some sort to move the valves from their seats, hence the importance of light valves and carefully adjusted springs—nevertheless on this class of work we have regularly run up to within ⅝-in. of perfect vacuum. Surface condensers are used on this class of work, the condensed material being valuable. In the plant where I am now engaged our pump on the evaporators discharges against a vertical head of 22 feet, and a horizontal run of about 73 ft.; but as this pump handles large volumes of water, we still find it possible to average 28½-in. vacuum. The discharge passes down through a cooling tower, thereby enabling us to operate on about 3,000 gallons.