PEPPER

Foundry Methods for Cheapening Costs of Production

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FOUNDRY METHODS FOR CHEAPENING COSTS OF PRODUCTION

BY

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THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

CURTIS GORDON PEPPER

ENTITLED FOUNDRY METHODS FOR CHEAPENING COSTS OF PRODUCTION

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I N T R O D U C T I O N.

Previous to the last few decades of the nineteenth century the industry of metal founding received but little attention from men of any technical education or extensive business experience. A few of the simpler foundry appliances were brought together in some sort of a building, designed only as a protection from the weather, and placed under the charge of a man who had, in the majority of cases, risen from the ranks of the common laborer only by his skill in the moulding trade. Then came the present period of great national prosperity and capital with which to build. Larger and more extensive manufacturing plants became abundant. Numerous skilled business men, in company with highly trained engineers, installed new and modern foundries which quickly threatened to force the older plants into bankruptcy. As a result the industry of metal founding has become the center of a great industrial struggle. This competition is helpful to the business but results in the cost of manufacturing being of the most vital importance, and in the majority of cases, determining who shall have the contract.

As a result of this competition, therefore, the great slogan of this industrial age is economy, and manufacturers of today are deeply interested in any and all improvements tending in that direction. Although improved methods are constantly decreasing the cost of manufacture, the initial expense of raw material is increasing, as is also the wage scale, both for workmen and superintendents. As a result of these increasing expenses, attention is being given to securing a maximum efficiency of the workman and the largest possible production.

It is the purpose of this paper to set forth in a manner as concise and complete as possible, the problems which influence the cost of production and the methods in use today for their solution. It is very evident that two of the most important factors in this subject are the use of special and modern tools, and the economy in the use of the raw materials. Besides, and in a manner distinct from these considerations, there is the problem of the construction of the foundry building. This with a little attention will be seen to be a subject worthy of the most careful and expert investigation. Raw materials can easily be changed and tools rearranged to suit the occasion, but the defects in a building once up cannot be remedied without serious interference with the work, and very heavy expense. The foundry building, besides being merely a

shelter from the weather, is, to a certain extent also a tool, and requires the special knowledge of a highly skilled engineer for its economic design.

C O N S T R U C T I O N   O F   T H E   B U I L D I N G .

CONSTRUCTION OF THE ROOF.

In the construction of the roof there are two points to be considered; first, the construction of a roof of sufficient strength to stand any heavy snow strain to which it may be subjected, without undue bracing to the foundry floor; and second, its power of resisting the elements, such as hail, moisture, and gases, which tend to destroy it.

It is very evident that the floor of a foundry should be as clear as possible of all permanent obstructions. There should be nothing in the way of any load the crane should happen to be carrying from one end of the foundry to the other. Free passage must not only be given to the crane but also to any large trucks etc. which may be used for transporting any large or heavy articles. The floor around a post or column soon becomes littered up with odds and ends which should either be destroyed or put away in their proper places. In this way, much valuable floor space is taken up which --- should be used in increasing the output . For the above reasons the foundry should have a truss roof. The design of this roof should be placed in the hands

of a capable and experienced engineer, as the shutting down of the foundry during repairs incident to a breakage of the roof, would cause the loss of much valuable time. It is better to build at additional cost than to take any risk in this direction.

No really perfect roof covering has ever been tried. Slate makes a very good roof but a heavy hail storm is likely to splinter it. If slate is used however, care should be taken to procure only the best quality. This should be used on a good, stiff wood sheathing preferably flooring which is well covered with a layer of first class roofing felt, or it may be wired to steel slanting angles placed about ten inches apart. This latter construction is more expensive than the other, but there is absolutely no danger of fire. Asbestos and tin may be used, but need frequent repairs. Iron is totally unfit, as the gases and other peculiar conditions to which it is subjected cause it to rust away very rapidly. This will be explained more fully under the subject of " Foundry Walls." A very good form of roofing is the patent or paper roofing, well tarred and graveled.. This covering is very inexpensive at the out set and is very easily repaired. If given sufficient attention and well taken care of it is perhaps the most economical of roof coverings.

The "cementine" construction has been much adopted of late and is proving very successful. This covering is made of steel imbedded in concrete. The steel

frame work is of a medium weight, expanded metal lath on which cementine is built to a thickness of from two-and one half to three inches. The material used in this concrete is boiler cinders, sand and cement. The proportions used in mixing vary greatly, being one part of cement to one,two,six, or seven parts of clinkers, according to the size and condition of the latter. This concrete is very tough and may be struck with a sledge without damaging it. The cinders themselves seem to turn into a form of concrete. This roofing may be put up in panels of ten foot span without any danger of failure. The cost of the material is not great but the labor involved in erection is considerable and makes the first cost rather high. But the construction is cheap in the long run as it is practically ever-lasting.

THE FOUNDRY FLOOR. This is a subject of great importance in the construction of the building but it is one which is often overlooked and upon which very little thought or investigation seems to have been expended. Different manufacturers differ in regard to the floor. One thing however is certain, no matter what initial construction is used it must be covered with either wood, or some form of dirt or sand. Workmen cannot work many hours on their feet on a floor of concrete or some other such unyielding material. Asphaltum flooring does not tire the feet so much but is

frowned on by many managers, and wood is much preferable.

Either concrete or asphaltum makes a good floor if covered with wood blocks. The floor is laid first as in the concrete construction. Then sand is strewn over this to a depth of about two inches . The blocks are then laid upon this sand. These blocks should be of the best quality of yellow pine, paving blocks selected especially for smoothness and freedom from knots which would tend to make the floor wear uneven. . The blocks should also be sawed with the ends exactly perpendicular to their sides. If this is not done the blocks can not be laid true and the floor will be very rough and totally unfit for use. Too much stress can not be laid upon this point. The blocks should be carefully inspected in this particular before they are accepted. They are then stood side by side as closely as possible with their ends imbedded in the sand. Care should be taken that they are being laid level, with no low spots in any corner of the room to collect dampness. When they have been placed in position sand should be sprinkled over and into the intersections between then and packed down carefully. The whole floor should then be rolled carefully with a heavy roller. This makes a very good floor and the cost, although not so low as in others, is not prohibitive.

Another good floor is made by simplying excavating to a depth of two to three feet and filling in with a good quality of sand, common moulding sand making a very good floor. This floor is cheap, comfortable and besides being economical in first cost, requires practically no repairs. It also holds a small quantity of moisture well and keeps the moulding sand from drying out.

The cementine construction makes a very good and strong foundation for this floor. Wood blocks laid over it make a very lasting and indestructible floor. This construction is very good when the floor is to be laid in the second or third story of a building, as is now being done in some of the city locations, because of scarcity of room . Such a floor is stiff, yet elastic. A very heavy metal lath is used. With a good sized span, a marked deflection can be noticed with a heavy load, yet it returns back to its place when the load is removed. In erection, it is necessary that the arrangement be such that the steel is placed in tension and the cement in compression, as the latter has very little tensile strength. The result is that the floor is just as strong as the steel laths, as when the floor fails, it is the steel which yields because its tensile strength is less than the compressive resistance of the cementine.

THE WALLS. In the construction of the walls it is again evident that the most economical construction is that one which, with a minimum cost of material and labor, is the most lasting. Iron and steel have taken the place of wood wherever possible. The conditions which have brought about this change are too well known to need recounting here. The iron clad building of to-day is a construction which commends itself principally on account of low first cost, fire proof qualities and ease of construction. It also requires no separate foundation for the side walls. The material used is either corrugated iron or steel, either black or galvanized. If black a protective coating of paint is absolutely necessary and is usually put on galvanized iron.

The great and almost deterrent objections to this construction are the short life of the covering despite the constant and costly attention necessary to keep it in repair, and the poor protection it affords against changes of temperature. This changing temperature is its worst enemy, for the moisture which condenses on the surface as the atmosphere cools off, will reach the metal through the innumerable small cracks made in its protective coating by constant contraction and expansion. If, as is the case in the foundry, this moisture is saturated with acid gases, the final

result is hastened. Evidently then corrugated iron or steel is in reality not the most economical covering for the foundry building.

For the side walls and partitions a most excellent material is brick, and as the now usual steel skeleton construction does not require them to act as supports for the floors or roofs, they may be made as thin as will insure their stability against the vibrations due to the passage of railroad trains, for very few foundries are far from the main line and the machinery of the plant. It is very poor economy to use any thing but the best mortar for the joints.

The cementine covering makes a perfect covering for the walls and is being largely adopted all over the country. This covering is hung upon the frame work and a wall only two inches will do the work of an ordinary brick wall. As this system admits of the omission of the wall foundations and the thickness of the wall does not depend on the light in any degree whatever, a wall forty feet high is no more expensive per square foot than a wall ten feet high. The construction is absolutely fireproof, does not sweat, and is warmer than a brick wall because less porous and a poorer conductor of heat. This construction appears to be the ideal one for foundry buildings, for it combines low first cost with strength, the cost not exceeding that of any first

class construction while it is absolutely fire proof; the repairs are nominal; it will out last any other construction and it makes a pleasing appearance.

Fig 1

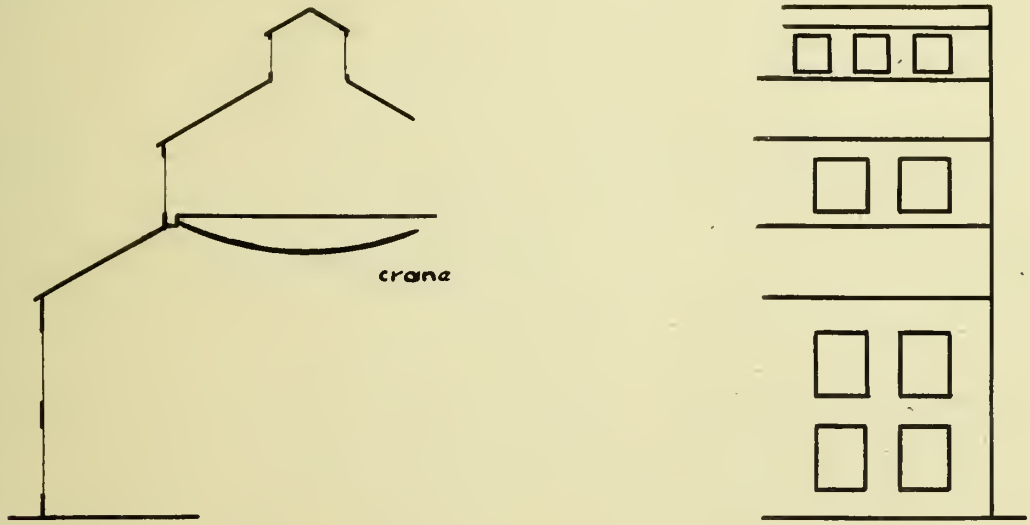

Fig 2

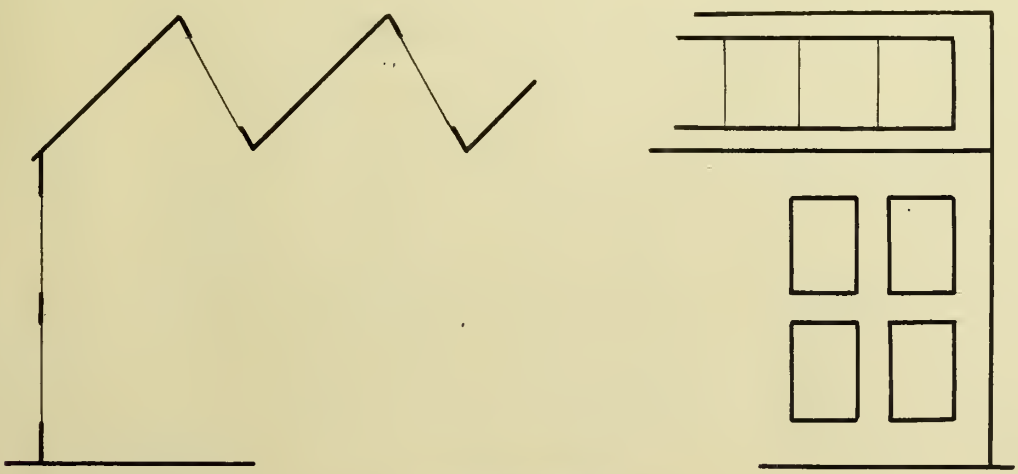

Fig 3

PLATE I

LIGHTING. It is very evident that the subject of lighting is of the utmost importance in the design of the building. It is apparent that the labor in a poorly lighted building will cost more than in a well lighted one, as the men can work faster in the latter; also by saving time on each operation the manufacturer is enabled to use his floor oftener and so increase his output. The number of windows must be considered and also their distribution. This latter should receive special attention in order that the areas lighted up by each may not overlap. They should be placed so that they can be easily cleaned, for if this is not done the foreman in charge of the work is liable to allow them to become almost opaque before he puts himself to the necessary trouble to clean them. Another very great help in having clean windows is to keep them from getting dirty. This, however, in a foundry, with its unavoidable dirt and gases is an exceedingly difficult proposition. It may, however, be accomplished, in most cases at least, by an efficient ventilating system.

Three of the lighting systems most in use at this time are shown on Plate "1". The lighting shown in Figure 1. is sufficient for use only in small shops, say from fifty to seventy-five feet in width; beyond this the system becomes inadequate and one of the methods of Figures two and three should be adopted. In the arrangement shown in Figure one the crane, if any is

used , is generally supported by girders extending from side to side, and supported by the brick walls, as there would not be enough room above the windows unless the lighting were seriously interfered with. The roof and upper walls should be kept painted white or some other light color, so as to reflect the light. The windows are very easily cleaned and taken care of, which fact is a decided advantqge.

The system shown in Figure Two is one quite generally found in this country. It is fairly efficient and offers an easy and cheap method of construction. The number of windows upon the sides will depend of course, upon the height of the walls. It is impracticable to make the windows of a very large size, both on account of the large initial cost and the great expense of replacing them should they become broken. Some foundries have as high as four tiers of windows in the side walls. The small windows at the extreme top may well be dispensed with as they are of very little use except for ventilation. The row of windows above the crane track is very useful in illuminating the crane interior and general foundry, but is very difficult to clean.

The arrangement in Figure "3" is by far the best of any system yet designed. The initial cost is perhaps greater, but in all other respects, except the convenience of cleaning the windows, it is much

superior to the other methods. The roof being built on the saw tooth principle, there is a glass skylight in each bay running the entire length of the foundry and limited in width only by the height of the roof. This gives a very large area of lighting surface, making the interior of the foundry almost as light by daylight as it is outside, a result not equaled by any other system of construction. The glass in the roof lights should be of special construction, say of one-fourth inch rough cast plate glass, having a wire mesh cast in, thus increasing its strength and enabling it to withstand the roughest usage.

Very little need be said on the subject of artificial lighting, as this is a superficial construction and may easily be changed to suit the needs of the occasion. Electrical lighting is preferable both from the fact that it gives better light, and also from the fact that the electrical energy introduced into the building for this purpose, may be used for running the cranes and other tools. If the artificial lighting is to be much used, the entire interior of the building should be painted white, as this increases the efficiency of the artificial light very considerably.

HEATING AND VENTILATION. The building having been properly designed for lighting, the question of heating and ventilation should next be considered. As these two subjects hinge upon one another very closely they should be considered in connection with each other. Heat losses occur in the building from two causes; first, by the direct transmission of heat by radiation through the walls and other exterior surfaces of the building ; and second, by the inflow of cold air from without. In designing a heating plant the first of these losses may be accurately calculated by referring to tables which have been prepared showing the radiation under different conditions through walls, windows, doors, roofs, etc. The heat lost by infiltration however, varies so greatly under different conditions, that no definite rule can be found. The allowance to be made for this therefore is necessarily a result of experience and knowledge of the results of previous installations.

In either fan or direct radiation systems difficulty is liable to be experienced by having a stratum of heated air forming just beneath the roof. As the roofs of foundries are generally of great height and plentifully supplied with glass, this heat is of little or no use and is quickly lost by radiation. This passage of heat to the top may be partially uti-

lized in direct radiation by placing the radiators along the base of the walls, and allowing the heat to pass up along them on its passage to the roof. This method, however, has a tendency to waste heat by unduly heating the walls and causing excessive radiation. In this system, as the air currents are produced entirely by heating, one of the above losses cannot be prevented, and for this reason the direct heating system should be avoided whenever possible. In fan systems, however, as the air diffusion is entirely mechanical, the passage of heated air to the top can be obviated. These systems, in general, depend upon securing a perfect diffusion of air near or along the floor line and will be described in detail later.

A second difficulty in high buildings, such as foundries and machine shops, is the effect due to outward leakage of heated air at the top of the building and the consequent inward flow of cold air along the floor line. This leakage is due to the unbalanced pressures of the column of heated air within the building and the surrounding cold air without. The tall building acts exactly as a large chimney. The difference in pressures is directly proportional to the difference in temperatures between the air within the building and without. Since the flow of air is proportional to the square root of the difference in pressures,

the leakage will be in proportion to the square root of the difference in temperatures. This theoretical conclusion is extremely well proved in practice.

As this escaping air is the very hottest contained in the room it is evident that its heat has not been fully utilized in heating the building, while the air which enters along the floor line cools the air in the lower part of the building very perceptibly, sometimes forming a cold stratum of air along the floor to the depth of from four to six inches. As much of the work in the foundry is done upon the floor, this is very disagreeable and detracts considerably from the efficiency of the workman, besides being uneconomical from the standpoint of the coal-pile. The heat lost in the upper part of the room may be much more than sufficient to heat the building comfortably if properly applied. The most effective remedy for this evil is to maintain a slight pressure within the building by means of a fan drawing a part of its air from without. This causes the air to discharge equally along the floor line and the top of the room, and so avoids the chilled floor.

Another objectionable feature in large buildings with a large skylight area is an excessive, cold down-draft in the center of the building. In wide buildings where the heat is distributed around the walls, this is especially noticeable, and as it comes directly

on the head and shoulders of the workmen in a part of the building most used, is very objectionable. This can easily be remedied with a fan system by causing a flow of heated air towards the center of the building.

There are two general and distinct ways of heating a building. The first of these is by keeping the walls and roof warm. This is accomplished in direct radiation by putting the radiators along the base of the walls, and allowing the heated air to pass up along the walls to the roof. In a fan system the result is obtained by blowing the heated air directly against the walls. The second method of heating is by heating the interior air directly, and can be accomplished in a satisfactory manner only by an indirect or fan system. If either of these two methods is used exclusively the second one is preferable, as it is much more economical than the other. In the first method it is evident that if the walls are kept sufficiently warm, there will be no radiation from the interior of the building and the heating effect will be entirely satisfactory,. On the other hand, it is equally apparent that the heating of the walls to a higher degree than the interior of the building will result in a much greater loss of heat by radiation through the walls than if the air had been heated directly and they were only at the temperature of the room . The loss by this system is therefore, very great

and may amount to as high as twenty-five per-cent or more of the total heat supplied. As a result of this inefficiency I shall not consider this system further, but shall confine my attention to the fan or indirect system.

In this system the first thing to be considered is the source of the air supply. There are two distinct methods in use at this time, the plenum system and the return system. In the first system all of the air passes through the heating coils into the room from outdoors. This produces a plenum in the building and the air is forced out, either through natural openings, as is the case in most foundries, or through specially provided vents, as in all large public buildings.

The second system which is perhaps more common in structures where forced ventilation is not a necessity, draws all of the air directly from within the building, and after heating, again forces it through the heating ducts. This is a very economical system and where properly applied secures excellent results.

The first of these systems has the advantage of securing an excellent ventilation, and in the case of foundries with their injurious gases, this is generally desirable. It moreover causes an outflow of air through all the openings of the building, which would otherwise be admitting cold air to settle along the floor and seriously interfere with the heating. In loosely construct-

ed buildings this is evidently the only system which can be used with any degree of success.

In the return system, as the entering air is the heated air from within the building, all of the heat supplied is instrumental in heating and in this particular it has an advantage over the plenum system. It, however, does not possess the advantage of causing a pressure within the building, which in many cases is imperative.

The ideal system is a combination of these two systems and should be used whenever possible. In this system a great portion of the air is returned to the heating apparatus but enough is drawn in from without to cause a plenum in the building and prevent the inward leakage of cold air from without. In this manner the natural leakage is supplied, not with cold air from without but with heated air from within. The amount of air drawn from without should be just sufficient to cause the noticeable inward flow of air to cease and perhaps, a very slight outward flow of air. If the plenum is carried beyond this point, it will result in an uneconomical heating of the outside atmosphere. This system when properly installed and cared for, has been found by tests to be much more economical than the return system alone.

After the question of air supply has been settled the problem of its distribution must receive

attention. There are several systems of distributing the supply of heated air from the heating system. One method very common in office buildings is to have vertical ducts or flues built in the walls and opening along a line about eight feet above the floor. The heated air is forced into the room through these and drawn outthrough

suitable openings along the floor line. In this manner the air is continually forced downwards as it cools and the cold air is removed at the floor. This method is very good, and is some times used in foundries, but the large expense of installing it is rather prohibitive. Another method very often found in foundries and much more inexpensive is very similar to this one. The air is first blown into brick ducts placed underneath the floor. From these ducts vertical,galvanized iron risers are placed along the walls, so arranged as to blow outward and downward at a height of about eight feet from the floor. The outlets of these risers should

be adjustable so that in case too direct a draft is caused in any portion of the building, they may be diverted so as to blow the air in some other direction where the air currents are not objectionable. The general arrangement of this system is shown in Plate 2.

The advantages of this system are: first , that there is no overhead piping in the way of cranes, etc. ; second, that the greater part of the distributing system is of brick and is not subject to

deterioration; third . and principal advantage, that the air can be distributed by this means wherever it is most needed. The system is sometimes slightly modified by placing the outlets close to the floor and blowing downwards directly along the floor, as shown by the dotted lines in the figure. This is a good scheme as it insures a perfect distribution of warm air along the floor line and avoids any draft which would be objectionable. If the foundry is too wide to be thoroughly heated by these methods another row of risers may be placed along the center line of the room, where they will be protected by the columns supporting the roof. One or two large heating units placed at or near the center of the building may be made to heat the entire building very easily by connecting them to the brick ducts by other passages from the center of the building to the walls.

Another system which has proved very satisfactory is a combination of the plemun and exhaust systems, in which a distributing air duct is employed. In this system several small heating units are employed and are placed around the foundry walls in small frame houses provided for them. The peculiar feature of this arrangement is that no distributing ducts or pipes are used for distributing the heated air, the air being blown directly into the room through outlets, branch-

ing in several directions, at a height of from eight to twelve feet above the floor. The air distribution is effected entirely by the exhaust vents which are placed at frequent intervals along the floor of the room . These open into large return air tunnels, which convey the air back to the fan and also serve the additional purpose of providing a convenient place for locating steam, water and electric mains. Provision is made for securing a part of the air for the fan from outdoors, so as to insure a plemun within the building. A great advantage in this system is that it removes all cold air that may leak in at the floor line as well as that produced by the cold down draft along the walls. Further, a perfect distribution of all parts of the building is effected and the expense of installation is reduced to a minimum. This system is illustrated in Plate III . In small buildings distributing outlets are placed along the further side of the building and a system of vents is placed on the side adjacent to the fans.

Together with the advantage of the fan system in securing a satisfactory and economical heating with any desired degree of ventilation, it combines both a saving in the first cost, and economy and convenience in operation to a greater degree than any other system.

The required amount of heating surface in a fan system is reduced, on account of its greater efficiency to less than one third of that necessary in adirect system. This larger efficiency is due to the much larger amount of air brought in contact with the heating pipes in this than in the direct system of radiation. It has been found by experiment that the radiation from the fan system heating surface increases more rapidly than the square root of the velocity. Hence the higher the velocity secured over any heating surface the greater will be the radiation per square foot. The cost of driving the fan is very slight as the exhaust steam can be used for heating.

That the fan system is becoming recognized as the most satisfactory method of heating is shown by the fact that it is being exclusively adopted in all railway shops and by the more progressive manufacturers throughout the country in their foundry buildings.

S P E C I A L - T O O L S - A N D - A P P L I A N C E S .

PNEUMATIC TOOLS.

The introduction of pneumatic tools in a form perfected for shop or foundry usage dates back but a few years, and their wide spread adoption, remarkable for its rapidity, is a very convincing proof of their commercial value. To-day a boiler shop or machine shop, devoid of compressed air equipment is a rarity, and if the foundries are not so well provided for, it is because the merits and labor saving properties of pneumatic machinery have not yet been thoroughly demonstrated to the foundry managers. Certain defects in the old style of tools, the want of knowledge of how to operate them, together with the prejudices of ignorant workmen, have resulted in the condemnation of these tools in many foundries. One of the objections of the old style of tools was the recoiler kick. This kick has done more to prevent the adoption of large sized pneumatic tools than any thing else, as it has enabled the workman who is afraid of losing his place to say, with some appearance of truth, that holding the tool was injurious to him, producing paralysis of his arm, etc. New and improved tools have been lately put on the market, how-

ever, so constructed and so evenly balanced that all kick has been eliminated from them, because they have air cushions so placed that the operator, when using them, is really pushing against air, the elasticity of which takes up all shock and vibration.

Another objection which has been urged against these tools is that so many parts, valves, springs, etc. enter into their construction. Such a number and vareity of parts make the tool very liable to get out of order. This objection is, however, being very largely overcome by several new and improved designs recently placed upon the market.

In the use of these tools it is very important that the air pressure be kept up to the standard requirement, probably eighty to one- hundred pounds. Otherwise the tool will fail to perform its duty properly and give satisfaction. The air plant is therefore a rather important thing when used in connection with pneumatic tools. In the first place, an air compressor, an air receiver, and a number of different sizes of pipe strung around the shop, do not constitute either an efficient or economical air plant. To get the best results you require :-

First,- An air compressor of approved pattern, of sufficient size and power to develop and maintain a steady pressure of from eighty to one-hundred

pounds to the square inch.

Second:- An air receiver of sufficient size to equalize the pulsation of the compressor, and to cause the air to flow with uniform velocity to the tools.

Third:- As air in its pipes is subject to friction, in the same manner as water, it is important that the pipe system should be carefully designed, as loss by friction may be quite serious. In calculating such loss, it will be well to note that the difference in pressure between the entrance to the pipe and the point of use, termed in hydraulics "lost head" is not applicable to compressed air,. Compressed air will lose ten per cent of its head but the loss of power will only be about 3 per cent.. The reason for this is simple when it is considered that compressed air when it loses in pressure gains in bulk, and thus in a measure by its increased volume compensates for the diminished pressure.

The cost of such an equipment is rather excessive. Take an example. An air compressor was recently installed in a small foundry in Chicago. It was of sufficient size to operate three fourteen ounce hammers and required practically four horse power to run it. This compressor was connected by belting to a line shaft, as when a small compressor is used it is much more economical to run it by belt power than by steam directly.

This compressor cost very close to $ 180. The receiver cost $ 40.00 while the pipe necessary to carry the air a distance of about one-hundred feet cost about $ 8.00 The three tools of the capacity mentioned cost $300.00 This makes a total cost of $ 525.00 for the equipment. It will be seen that these instruments are very high priced. However, as they accomplish about three or four times as much work as a man turns out in the old fashioned manner, they will soon pay for them selves. The buyer apparently has to divide his profits caused by a saving in labor, with the patentee or maker, or perhaps with both. These tools could unquestionably be made and sold for nearly one third of the price for which they are sold at present; and if lower in price would undoubtedly be sold in larger quantities and more universally introduced in all foundries.

THE PNEUMATIC HOIST Perhaps the best known and most widely employed foundry appliance actuated by compressed air is the pneumatic hoist, originally used only in the straight lift, piston and cylinder form, but now used in a variety of types.

These hoists may be arranged to be used either horizontally or vertically, the latter style being desirable when available head room is scant. These hoists may be arranged for a lift of two feet or four feet

for each foot of piston travel, when so desired. Operated by a simple three-way cock, with no complicated mechanism, these hoists are well nigh indispensable for duty not requiring an immovably sustained load. For this latter demand, where irregular action is not permissible, a more improved type of hoist is obtainable in which the incompressible qualities of oil are used to govern and restrain the sometimes too elastic properties of compressed air. This is accomplished by providing the hoist with a hollow piston rod filled with oil, thereby preventing a more rapid movement of the piston in its upward travel. than omission of the oil through the regular controlling valve will permit. This form of hoist eliminates that element of danger which otherwise would be present in handling vessels of moulten metal, and also permits a sort of elastic, positiveness which is very desirable. In the actual work of moulds, drawing patterns and moving cores, the air hoists will do fifty percent more work in an easier and better manner, without danger of losing castings and with considerable saving in repairs. The peculiar adaptability of this hoist, properly rigged as a drop or casting breaker, is apparent, since it is evident that the sudden release of the load could not possibly affect the regular and even progress of the piston in its return stroke. This machine will break three half pigs

into three pieces each in one minute, and can easily break twenty tons of pig while a man is breaking up one ton by old sledge method.

THE MOTOR CHAIR HOIST. The Motor Chair Hoist is a more recently developed appliance, intended for similar service, and embodies compactness of form with rapid, even speed and perfect regulation. It consists of the motor, found on all pneumatic drills, so combined with a chain hoist as to permit quick movement, accurate suspension of load and prompt reversibility. One of the latest types operates the motor in a bath of oil, avoiding the annoyance sometimes due to insufficient lubrication because of the inaccessible location in which the hoist generally operates. These hoists, with adequate pressure, are made in sizes to lift up to ten thousand pounds in weight, at speeds varying from ten to thirty-six feet per minute.

THE PNEUMATIC HAMMER. A most useful foundry, appliance, familiar to every one, is the pneumatic hammer for chipping castings. This tool consists of only three parts, a cylinder that is bored out of a solid piece of steel, a hammer or piston made or tool steel, and a butt piece or plug to close the end of the cylinder. The only part that moves is the hammer, and that is not dependent upon the movement of any other part for

its own motion. If given fair treatment and regularly oiled it can be depended on for a long period of steady and reliable service and several dealers guarantee them against all repairs for a period of from one to three years, depending upon the service for which the tool is designed.

The average amount of work that can be done with this tool is as follows.

In removing sand from large and heavy castings, one man with a medium-sized tool and a broad chisel, can easily do as much work in a given time as six men could by hand methods.

One man with a tool can do as much light fine chipping as is usually done by five men in the same period of time, and when it comes to rough or heavy chipping, one man with the proper sized tool can do about the same quantity of work that is generally done by three or four men with the hammer or chisel. It is sometimes necessary to chip to a line or true surface. A man who is skillful enough to do this kind of work with a hammer and chisel can accomplish just twice as much in the same time by using a pneumatic tool for the purpose. The operator has absolute control over the tools used for this fine work; striking a light or heavy blow as he desires; governing the force of the blows by the simple pressure of his hand.

THE AIR DRILL. The air drill is another very familiar labor saving device in some classes of foundry work. When a large, heavy casting is to be broken up for return to the cupola, a small pneumatic drill may be advantageously used to drill a suitable number of small holes into which may be inserted a round taper steel wedge which, with a few well directed hammer blows, will sever the piece into parts suitable for remelting. The application of a drill motor to a casting cleaner is a great money saver because of its immense speed and power.

THE PNEUMATIC SAND RAMMER. One of the most recently perfected pneumatic devices suitable only to foundry requirements is the pneumatic sand rammer, now on the market in its most improved form. It consists of a vertical cylinder containing a piston driven by compressed air. This tool is attached to a movable crane or trolley by a universal joint so that it may be used in any position. Accurately counter balanced, the weight of the tool, completely rigged, is not quite three-hundred pounds, and operated under an air pressure of forty pounds to the square inch, it will deliver an average of three-hundred blows to the minute. The maximum stroke is seven inches but the length of the stroke and consequently the number of blows delivered may be

changed at the will of the operator by simply varying the distance of the rammer from the work. It is estimated that a greater quantity of sand can be rammed in a more effectual manner by this machine than five men can do by hand.

THE SAND BLAST. One of the oldest and most widely known contrivances, though perhaps not the most widely used, is the pneumatic sand blast. The sand blast consists of blowing fine sand through a nozzle, by compressed air at a pressure of about e ighty pounds to the square inch. This is blown directly upon the surface of the casting. The principal objection to this has been its wastful utilization of what was formerly a very costly commodity- compressed air- but this element of criticism is eliminated in a great measure because of the rapid strides in the development of economical and efficient air compressing machinery. On ordinary iron, steel, brass and bronze castings, one man operating a sand blast apparatus, consuming one-hundred and twenty cubic feet of air per minute, will clean more surface and remove more cores in a given time than is possible for from six to ten men to do with the hammers, chisels and brushes; The finished work left by the sand blast is infinitely better than can possibly be produced by hand laborers. Burned sand or scale is removed rapidly by the blast, and not only does it effect

a greater saving in time and labor, but a further saving is effected on castings to be machined; the removing of the oxide in itself is a great saving on tools and in many cases the tools can be run at greater speed. This applies particularly to milling cutters. Difficult and intricate cores are readily removed, and in cleaning steel castings in which great quantities of large nails are used, the sand is eaten away first and subsequently the wire nails will fall to the ground, sand blasted, perfectly clean, and in condition to be used over again. In a number of foundries where the sand blast has been introduced the use of facings has been discontinued. This however cannot be said to be a general practice. In some cases the only objection that has been made to the sand blast is its unpleasant habit of making defects too plainly discernible. No blow hole or crevice is too small to escape the tremendous searching powers of this blast.

A recent improvement in connection with the sand blast is its application in connection with rumbling barrels or rattlers. These barrels are run very slowly and consequently there is slight risk of breaking a fragile casting; neither are their edges worn off and destroyed, as is the case with ordinary rattling at high speed. The castings are not cleaned by the rumbling but by a sand blast inserted at one or both ends

of the barrel. The usual time consumed in cleaning a charge of this barrel is from twenty to thirty minutes.

PNEUMATIC SAND SIFTER. This is simply another utilization of the air drill motor to the needs of the foundry. It is nothing more or less than a large rectangular riddle connected by means of a short connecting rod and gear to a compressed air motor. As the motor revolves, the riddle is shaken back and forth with great speed. An ordinary sifter will sift sand as fast as a laborer will shovel it in. With compressed air available for its operation, the value of this apparatus through saving of labor and attention becomes readily apparent. It can be moved from place to place in the performance of its word, saving the time and labor otherwise required to convey sand to a fixed sifting point.

THE PNEUMATIC MOLDING MACHINE. The pneumatic molding machine will be discussed in detail later under head of " Moulding Machines " .

THE PNEUMATIC PAINTING MACHINE. The pneumatic painting machine mentioned because of its exceptionsl economy in painting the interiors of the foundry building, possesses advantages of keeping the walls and roof of the foundry building well painted. This has been

discussed earlier in this paper. The painting machine is a small can, holding from one to three quarts of paint from which paint is sprayed in any desired direction by means of compressed air. One man with this handy utensil can cover more space and distribute the paint more evenly than four men using ordinary paint brushes. The air consumption is moderate and the results all that can be desired.

To derive the utmost benefits from the installation of compressed air machinery, tha selection of a compressor should be carefully considered. It is unwise to install a compressor just about equal in capacity to present requirements, good practice being to provide a compressor with at least fifty per cent greater capacity than immediate necessities demand. Compressors of the duplex type are divisible, permitting the installation and operation of one half at first, the other half when the additional capacity is needed. The theoretical capacity of an air compressor stated in the list of the maker is not the equivalent of the actual volume of air needed for the service. All makers list their compressors according to the theoretical measurements, but the efficiency of the compression is determined by the volume of air actually delivered with a given consumption of power. The cheap air compressor usually proves the most expensive. If a water pump fails in its

work or if a steam engine is deficient, the shortcomings are self evident, but if an air compressor is poorly designed or badly constructed, it may continue in the evil of its ways until the scrap heap claims it for its own; unless as is more likely, an absolute breakdown calls attention to its deficiencies and shows, all too late, that the hole it has made in the coal pile, added to the cost of keeping it in repair, would have paid a handsome interest on the first cost of a properly desigred and constructed compressor. Secondhand compressors are poor investments, unless known to have given satisfaction in service similar to that for which intended, and in any case, the working parts should be carefully examined to see that they retain their full measure of usefulness. An air compressor with valves, pistons, etc, worn out or in bad repair, can waste a great amount of power.

The use of air brake pumps and direct acting compressors is very bad practice, as statistics and tests show that their steam consumption is about five times that of a crank and flywheel compressor for the same volume and pressure of air delivered. Install a steam-driven compressor, if the required capacity is great and the steam plenty, otherwise a belted compressor may serve best.

Intake air should not be drawn from a hot engine room, or from the foundry or any other point where the dust is abundant. The volume of air delivered by compressor increases proportionately as the temperature of the intake air is lowered; and dust or grit, entering the compressor, clogs the valves, cuts the cylinders and generally impairs the efficiency.

The selection of an air receiver should have careful consideration. Compressed air under one-hundred pounds pressure will leak horse power through a one sixteenth of an inch hole in five minutes, and a well made, strong and tight air receiver is the second essentially important factor if the advantages which compressed air provides would be realized to the utmost.

The air piping should be tested under full pressure when it is installed, and at regular intervals thereafter, allowing the pressure to remain an adequate length of time: If the gauge indicates leakage, it should be located and remedied. To secure the best results and eliminate moisture from the compressed air, the pipe should be connected so as to lead from the compressor to the top of the receiver, and the air pipes to points of consumption should lead from the bottom of the receiver. Proper provision should be made for draining condensed moisture at regular intervals in the system. The simplest method is to slightly incline the

branches leading from the main line and insert drain cocks before the hose connections are reached. In pneumatic equipment, as in many other things, the proverbial ounce of prevention saves the pound of cure. Experienced knowledge which the compressor maker or pneumatic tool manufacturer is ready to provide, coupled with sound calculation, will insure the highest results and utmost economy. Whether to put in a steam-driven or belt-actuated compressor; whether it should be of the duplex or single type and have simple or compound cylinders; where best to locate the compressor and where to place the receiver; what size of receiver is adequate; whether the size of the plant warrants provision for reheating the air, all these are points requiring the most careful consideration. In securing pneumatic equipment it is generally desirable to secure the entire outfit from one source. Thus division of responsibility for the successful operation of any feature of the plant is avoided , and one guarantee covers everything.

MOLDING MACHINES. It is the natural tendency of all foundry owners, superintendents and wide-wake foremen, to increase the production of their foundries with the least possible expenditure; and therefore less experienced men will be intrusted with work which becomes more and more difficult to perform. Mechanical means

and contrivances must then be employed to encourage green hands to expedite matters, and to insure success. All such labor saving devices are especially designed for the purpose of insuring a larger output, and to obtain more, better, cheaper and uniform castings, and in some degree to take the responsibility from the molder and shift it upon the shoulders of the patent pattern maker. But while such mechanical means are almost a necessity in the hands of less experienced men, they are also a great convenience and material help to the expert molder.

Nevertheless, the introduction of the molding machine into the foundry has been the cause of many a heated argument. Articles have been written and discussed from a trade's protection standpoint and vice versa; also from the standpoint of the incessant demand upon the market for increased production of certain articles, thus necessarily compelling the foundrymen to wake up and supply the demand.

The molder refused to work upon these machines or at least refused to"put up" the amount of work necessary to pay for the investment simply on account of the fact that he became a mere automaton. The mechanic who worked these machines was a mere pounder of sand, and consequently in order to bring these machines into successful use the manufacturer was com-

pelled to employ unskilled labor. The molding machine has been in the foundry for a number of years, but only recently has it received the attention which it deserves, and that simply because competition has made the progressive foundryman devise the most effective and economical methods to produce the best results, and at the same time get as near as possible perfect castings.

One of the accomplishments which must be attained in a successful foundry is the ability to carry on the work in the least possible amount of space, more especially in prosperous times when floor space is at a premium, all foundries being then too small for their requirements. Here is where the molding machine becomes a necessity.

THE PLATED PATTERNS. The simplest of all labor saving devices for molding is the loose gate or runner. This is placed on the mold board, next to the pattern and rammed up with it. Its advantage is evident in saving the hand work necessary for cutting the gate in the sand. In some instances these gates are directly connected to the pattern, forming one piece with it and saving the separate lifting of it out of the sand. Two or more patterns are frequently secured together to form a gate; sometimes, especially in the case of small castings, a dozen or more patterns are thus fastened together.

Many molders prefer carded or plated patterns, i.e. patterns fastened to a plate, to the usual gated ones. They have a great advantage over the latter as they are stronger and can stand more abuse.

It is sometimes advantageous to use two independent plates for one set of patterns. If this is the case one of them will be used for the drag side and the other for the cope side of the patterns. Should these two plates be held or secured together with their backs adjoining they would be practically the same as the above mentioned cards.

Matched plates must be used with gated or carded patterns to insure satisfactory results. They are rarely necessary when the pattern is placed on one side of the plate only. Using the face of a straight mold board as the bed for the plate to insure molds true to pattern will be found sufficient in most instances. By working each half by different men, double the quantity of castings can be produced in the same time with patterns arranged in this manner than when gated or carded. But it requires a set of carefully prepared flasks, which are especially fitted to the plates, to enable their use and successful application.

The shape of the patterns often permits them to be molded with either side in the cope or in the drag. When this is the case, they can be advantageously secured to

one side of the plate only, and the same plate, or rather the same side of the plate is used to produce both cope and drag.

Patterns prepared in this manner belong to a group possessing radically different characteristics from those of the foregoing. The nature of this arrangement involves some intricacy, and to insure good castings the fastening of the patterns to the plates demands the utmost accuracy and greatest care at the hands of a skillful mechanic. A simple illustration will best serve to explain this subject.

Let us assume that we have the pattern of a pinion with a flange on one of its sides. Ordinarily, we should leave the flange loose, place the toothed portion of the pattern on a mold board, ram it up in the drag, then turn over the drag and pattern, put the flange in place, ram up the cope, lift off the cope, turn it over, withdraw both parts of the patterns, and finally close the flask. When plated patterns are used we make two pinions in one flask, by securing the toothed portion and the flanged portion separately, but in exact alignment with each other and at equal distance from the flask pin holes, on the same face of the plate.

Thus prepared the plate is placed on a mold board, a portion of the flask placed over it and rammed up with molding sand, and naturally we get an impression

of each of the patterns in the same part of the flask. The same process is then repeated with the second half of the flask and the same impressions are obtained in this one. Now in placing these two portions of the flask together, it is only necessary to observe that the cope is turned in such a manner that its flanged portion will cover the toothed portion of the drag and vice versa. To avoid possible mistakes of this kind, each flask has only one pin which fits in a corresponding hole in its mate. The mold board is provided likewise with one pin and one pin bushing and carefully fitted to plate and flasks.

The advantage of this method of molding over the ordinary practice is apparent. It insures double the output with the same number of patterns and the same expenditure for labor. Good patterns with plenty of draft are easily withdrawn from the mold by carefully raising the plate. More or less rapping is necessary if the patterns have little or no draft or if their shapes are complicated. The rapping of the plate must be avoided. It is of little or no use if the plate fits closely to the flask pins as it should. In all cases the rapping will have a tendency to damage, not only the plate, but also patterns and flasks. This suggests the use of a double plate, one of them a stripping plate, which lies nearest to the face of the flask

and the other one a draw plate to which the patterns are secured. If held together and guided by independent pins which can be located outside the frame of the flask and moved in bushing which should be closed above, we have a serviceable inexpensive substitute for the molding machine. In fact, a hand operated device, it is undoubtedly a very close approach to the more elaborate and more expensive molding machine. Before leaving the subject of plated patterns, plates with movable patterns and plates with movable portions of patterns should be discussed. These plates, in a manner distinct from the ordinary plated patterns may be well termed as mechanical pattern plates.

Many patterns have projections which make their withdrawal from the sand impossible without extra operations. Such projecting portions are usually secured loosely to the pattern by dovetails or dowels, and arranged in such a manner that they will remain in the mold when the main body of the pattern is lifted out of it. They are then picked out separately and great care must be exercised by the molder that his mold is not being destroyed while he accomplishes this operation. This is always a tedious and costly manipulation, and gives just cause to the expressed desire of the molder that the designer of such patterns should be compelled to serve a just and legal time as apprentice in a foundry.

When such obstacles can not be avoided they can be frequently overcome by withdrawing them within the patterns by such mechanical means, before the main body of the pattern itself has been removed from the mold. Single patterns can be equipped in this manner, but especially when metallic and plated patterns are used, such an arrangement is always advisable, and its application in practice will give not only satisfaction, but it will prove to be of advantage to the manufacturer and a considerable convenience in the hands of the molder.

Plates when properly equipped are also admirably adapted to withdraw the entire pattern from the mold, before the flask is lifted off. This arrangement is especially valuable for molding wire sheaves, pulleys, dices, wheels and other similar shapes which, when revolved about their centers will permit of their turning out of the mold.

Such a device, though only a plate with movable patterns, is practically a stripping plate molding machine in the fullest sense of the word. In fact there are few of the many elaborately designed molding machines more perfect , more effective or more serviceable than this. Its application, however, is limited; it is little known and rarely used. It is costly to manufacture, as it requires exceedingly careful workman-

ship, and an equipment of flasks which must be kept in excellent condition to insure castings.

All plates, as described, are used with good advantage independently, but they can, without any alterations, be used equally as well in connection with molding machine, and in most cases are actually one of the principal part of them.

THE GENERAL CHARACTERISTICS OF THE MOLDING MACHINE.

The object of machine molding is to save labor, to increase the output of a foundry, to decrease the cost of production, to produce more uniform and, if possible, better castings than can be produced by hand, and to employ the smallest possible amount of skill in these particular molding operations, which require a series of ever repeated, automatic movements.

It is obvious that it would require a complicated mechanism to perform successively and successfully all of the operations necessary to make a complete mold, even if it were only the mold of a simple pattern. And in consequence, the general equipment of a foundry, which accomplishes this object, must be quite an elaborate and extensive matter. The majority of designs of molding machines run in this direction, whereas, it would have been better in most cases if the energy expended had been directed towards their simplification.

Such tendencies lead to complications which are altogether unsuited to foundry practice; they meet with but little favor and machines built upon these principles are of short life. Only the simpler molding machine have a chance of meeting with more or less success, even if they perform but a few operations, providing they perform these well. Many foundries would be well satisfied if at least some of the more expensive operations could be performed satisfactorily with the aid of time-saving machinery. With this object in view some ingenious founder or molder originally devised a contrivance to withdraw his pattern from the molds by mechanical means. This probably occurred at least during the first half of the last century. The next step was to employ stripping plates. Conjunctively therewith it was attempted to ram the mold by machinery. These two operations, with drawing the patterns from the sand, and ramming the flask are the basic principles of all molding machines. Some machines are constructed to perform the one, some to perform the other operation and still another to combine both in the same apparatus. All subsequent improvements and additions are merely a matter of detail. However it must be said that it is due to the judicious selection and arrangement of the very details, and to the superior refinement and quality of workmanship employed in their construction, that modern molding mach-

ines have actually become a success.

Molding machines may be divided into two large groups according to the manner in which they are operated, that is, in hand and in power machinery . The former may be made stationary or portable; each class being adapted to the peculiarities of existing conditions and requirements. Stationary may be distributed to good advantage along the walls or in rows along the aisles of the molding floor. Quite frequently they may be fastened to benches, or to posts or to the walls of the foundry. In other instances they may be advantageously provided with individual stands. A selection from these arrangements depends largely upon specific circumstances and little can be said against or in favor of one kind or the other. Portable machines may represent the identical details of construction in their mechanism as stationary machines, but they are always provided with individual stands on wheels, which permit of their being easily rolled from place to place, following the sand heap and the flask pile on the foundry floor, and leaving the finished molds behind them.

A good object lesson on the advantage of moving molding machines was given in a pamphlet by Mr. Henry E. Pridmore, where in he explained that " for filling a foundry floor with two hundred and seventy 12" x 28" x 8" flasks by working either at the bench or with

stationary molding machines, two molders would have to walk seven miles and seven hundred and twenty feet, carrying a heavy flask over half the distance; while with the proper arrangement and with movable machines this distance was reduced to six thousand, four hundred and eighty feet or about one fifth of the above journey".

It is interesting to note that the quantity of sand alone in this case represents a mass equal in weight to about twenty tons, which remained practically at the same spot where used, while in bench molding or with stationary machines it would have to be carried over the given distance twice, that is, once from the floor to the bench before molding and once from the bench to the floor after molding. This sounds like a strong argument in favor of portable machines and it undoubtedly is, but portable machines are not always applicable and do away with the use of power, in a great measure at least.

Portable machines are good in their places but they are not good in all places. Molding machines can be made portable only where they are operated by hand, and economy by reason of their portability decreases as the size and weight of the machine increases. Machines driven by power depend more or less upon the fixed position and cannot be moved about. It is of course an object well worth of consideration in all cases to save time and labor in handling the molding sand, the

flasks and the finished molds, but other means than portability on the part of the molding machines must usually be resorted to, to attain the desired results.

The simplest of all molding machines is the "squeezer". As the name implies, it serves the purpose of squeezing, not ramming the molding sand into the flask. The object is accomplished by applying pressure to a plunger which is provided with a suitable press board, and compacting the sand in the flask by this operation. Properly speaking it is therefore a "Plunger Press" or a Plunger Molding Press.

The flask with follow or molding board and patterns is usually placed on a platen or table, and either the plunger is moved downward, or the platen with the flask is moved upward. In exceptional cases the plunger or plungers move horizontally. Either one of these arrangements accomplishes the end, but satisfactory results depend largely upon the details of the construction of the respective machines.

In most cases the pressure is applied by compound leverage, which, as a rule, admits of the simplest and most effective design. The moving portion of such machines, which are continuously exposed to the erosive action of the molding sand, and which on this account are subject to considerable friction and much wear, may therefore be made exclusively of pin connection. These are less expensive, and when worn more easily replaced,

than the parts of any other mechanical movement.

The great trouble with the "aqueezer" is that it makes the outer surface of the mold so hard that it is difficult for the gases to find an easy exit through the sand, In order to obviate this trouble a loose frame the size of the flask and about one inch and a half thick is placed over the top of the flask so that the mold is squeezed, This frame may be removed and the hard surface of the sand scraped in line with the flask. Another difficulty in employing these machines is that there is a large quantity of sand right under the operator's feet. In order to get rid of this sand the conveyor was designed so that the sand, as it is desired, would simply drop down upon the flask. This again has not proved as successful as might have been expected, because in many instances just as much work is accomplished by the use of the shovel, thereby saving the very expensive conveyers and shortening the great distance necessary to carry the flasks from the machine to the floor.

It requires but very little reasoning to prove that the scope of utility of the described form of "squeezers" encompasses but small limits, and that their successful application is strictly confined to the molding of shallow patterns. Unless in the case of deep patterns, ordinary hand ramming and piening is resort-

ed to at least for a part of the operation of compacting the sand, the simple manipulation of the flat bottom pressure head will give but a very poorly packed mold, which cannot possible result in satisfactory castings. It is liable to give rise to all sorts of trouble. The casting may not come out true to size or true to pattern; it may be swelled or rough in one place and not run full in another; the molding sand which has not been packed sufficiently hard in places may be washed off by melted metal, and as a consequence the casting may come out dirty nad unfit for use. Many other objectionable features may result, which would condem not only the casting but also the molding machine itself.

To obviate this, in a measure at least, imperfect ramming devices for ramming the sand instead of squeezing it have been perfected. These are practically always power machines, as it is impossible to strike a sufficiently powerful or rapid blow by use of the hand lever. Many schemes are in use but are all variations of the simplest type, in which the table is either forced quickly against the head piece or the latter downward against the table. It is but a modification of the squeezer in which the pressure is much larger and applied much more quickly than in the latter. This pressure is produced sometimes by means of belted power and a clutching device by which the machine may be thrown against the head-

piece at the will of the operator. or, as is the general case, by hydraulic or pneumatic power. In this latter method the entire platen is mounted on a plunger extending into a cylinder. Air or water is introduced into this under pressure, by the manipulation of a lever in the hand of the workman. This faces the table upward against the head piece with a force proportional to the width of the valve opening which may be changed for molds of different depths. This blow may be repeated if so desired by the operator. In this method more perfect ramming is secured and the objections against the "squeezer" are largely overcome.

It is well known, however, that patterns of different characters require different treatment at the hands of the molder, and that it takes a combination of good judgment and skill only to be acquired by long practice, to make molds of various shaped patterns which will always produce good castings.

In the ordinary method of drawing patterns, they are drawn from the mold by means of the spike and rapper wielded by the molder's hand after cope and drag have been rammed together on a squeezer and the cope has been removed. Frequently the "swab" is used to soak and so strengthen joint outline of the sand before drawing patterns, in such cases as this. In this case, before cope is lifted, these patterns must be vigorously rapped

throughout the cope; an amount depending, and so the size of the casting upon the wood and strength of the molder.

To obviate this rapping, the machines for drawing the patterns have been designed. These machines are used with and without the device for ramming the mold but their design and operation are the same is either case. There are two methods of drawing the patterns; first by drawing the patterns through as "stripping plate" or "drop plate", until recently the usual method, and record, by drawing the pattern without the use of this plate by means of a pneumatic vibrator. The patterns are effectively machine guided in either case.

In the first method the pattern is not rapped at all and is drawn in an absolutely straight line so that the mold is exactly pattern size.

The stripping plate is fitted accurately at the joint surface of the pattern, obviously at considerable expense, and, of course, at the instant of drawing, the patterns support the mold absolutely. This is almost an ideal method for drawing patterns and has for years been the only method practiced on machines. It has two disadvantages. The patterns are separated from the stripping plates by a necessary joint fissure between the two. Fine sand continually falls into this end, adhering to the joint surfaces and more or less, grinds the

fissure wider. This leads to a gradual reduction of sides of patterns on vertical surfaces and a widening of the joint fissure often to such an extent that wire edges are formed in the mold, causing, on fine work, "crushing" and continually dirty joints.

The stripping plate has another drawback not always appreciated, probably because accepted as inevitable . These patterns are not rapped and there frequently occurs on the surface of the patterns, remote from the action of the stripping plate, rectangular corners just as important to mold accurately as those at the parting line. Such corners have either to be filled or stooled in stripping plate work, and neither method is often practicable. When the entire pattern and plate are vibrated so that the corners where the pattern joins the plate draws perfectly it is obvious that similar corners anywhere on the pattern surface will draw equally well.

A machine that does this by means of a power driven vibrator has recently been put upon the market. It operates as follows: The ramming head, thrown back at the top of the machine, is drawn into a vertical position, after the flask has been placed and filled with sand, a threeway cock is then quickly opened, admitting compressed air of seventy or eighty pounds pressure to an inverted cylinder supporting the platen.

The cylinder with the entire upper portion of the machine is thus driven forcibly up against the ramming head, flask, sand and all. Often a single blow suffices to ram the mold, sometimes the blow is repeated, according to the demand of the particular mold in hand. Gravity returns the machine to its original position as the three-way cock opens to exhaust. After pushing the ramming head back and cutting sprue, if the half mold is a cope, the operator seizes a lever and drawing it forward and down, raises the outer frame of the top of the machine containing the flask pins, with flask and sand thereon, away from the patterns thus drawing them from the sand. Just as he seizes the pattern drawing lever with his right hand, he presses with his left on the head of a compression valve, thus admitting the air to the pneumatic vibrator.

This vibrator consists of a double acting, elongated piston having a stroke of about 5/16 inch in a valveless cylinder, and impacting upon hard wood anvils at either end at the estimated rate of five thousand blows per minute.

The action of the vibrator is such as to give the entire pattern surface an exceedingly violent shiver, making it impossible that any sand should adhere to this surface, while the magnitude of the actual movement of the pattern is so slight that it is found to

fill the mold so completely as to render it impossible to draw it a second time without rapping. Yet, so truly are the patterns held, and so little disturbed from their original position that it is perfectly practicable to return patterns to a mold having the finest ornamental surface in the ordinary process of "printing back".

A new and simple molding machine has recently been put upon the market by an Indiana firm. It consists of a substantial base upon which is placed a column containing a cylinder in which a piston, supporting the entire upper portion of the molding machine is fitted.

The flask is placed in the pattern plate and filled with sand. Air is then turned on by means of a valve connected with the supply hose or pipe. The parts are so constructed that as soon as the air is turned on the entire upper portion of the machine, including the pattern plate, stripping plate flask and all is raised and allowed to fall in such a way as to cause a rapid succession of blows of the lower end of the piston upon the base plate. This jars or rams the sand thoroughly. The mold is then struck off and the air turned on in such a way as to raise the table, when the table is given a rotation of ninety degrees and the air is exhausted slowly. The stripping plate, which extends beyond the

pattern plate, then catches upon some uprights placed on the machine for this purpose and so holds the flask while the pattern sinks away from it. The flask and stripping plate are then removed and the piston raised, turned through a quarter circle and again lowered into its original position, where it is ready for another flask.

The parts of this machine are so constructed that the piston forms its own valve and as there are no working parts, there is nothing to get out of order or get clogged with sand. The designers seem to have perfected the machine that is as simple as possible and which performs the two operations necessary to the complete molding machine, that is, ramming the mold and drawing the pattern.

It is a bad mistake to suppose that a molding machine of any description will replace a skilled molder. There is no less ingenuity required to make good castings upon a machine than by hand. A molder is aided by his experience and by his good judgment ; a machine hand has nothing to offer but his muscle and his good will. These qualities, however valuable they may be in some places, are at best but poor substitutes for the dexterity of an expert! This being the case, it is quite natural, that under ordinary circumstances the chances are but slight to obtain good castings

and general results by mechanical means which are imperfectly understood, and subjected to reckless abuse by hands which are unquestionably green at the business. For this reason, owners of molding machines should not expect marvels from them if intrusted to unskilled workmen, but it is safe to say that they will seldom fail in their calculations, if they are satisfied with a reasonably increased production providing they are willing to pay the best possible attention to the manipulation of the machine.

METHODS OF HANDLING MATERIAL, FLASKS, etc.

The different ways of handling the material and supplies both inside and out of a foundry are so many and so dependent upon local conditions that it is practically impossible to write upon the subject in a general way. Cranes, travelling and jib, are in general used in foundries of any size. They are generally operated by electricity although the jib crane is sometimes supplied with compressed air as a motive force. No foundry is complete or even fairly well equipped unless provided with sufficient crane power to handle any and all heavy loads it may be necessary to move.

In the handling of light loads two methods are employed, the narrow gauge track with its accompanying trucks or cars and the overhead trolley system, There is little to choose between these two, foundry-men being

about equally divided between the two. One or the other should penetrate every part of the foundry building and yards so as to be convenient for the transferring of any thing which is too heavy or cumbersome to be moved by hand. There should be sufficient switches or cross-overs to allow the carriers to pass between any two parts of the plant without transferring. Conveying loads by means of wheelbarrows is both tedious and costly, it taking longer to move anything and more men to move it. A manufacturor before installing any of the above systems however should visit other foundries in operation and study this problem carefully before investing his money in any system which may not be fitted to the requirements of the situation.