HINTS TO THE YOUNG STEAM FITTER.

BY WILLIAM J. BALDWIN.

The low pressure gravity circulation is at present very much used in the steam heating of private houses, churches, and schools. Its principal merits, when well done, are: It is safe; it is noiseless; the temperature of the heating surface is low and uniform; all the water of condensation is returned into the boiler except a very small loss from the air valves; it is easy to keep the stuffing boxes of the heater valves tight; and it is no more trouble to manage than a hot water apparatus.

There are four systems of low pressure steam piping, whose principal features are:

1st. Main distributing pipes and distributing risers, with corresponding return mains and risers (see Fig. 1, at A).

2d. Main distributing pipes and distributing risers, with a corresponding return main and a separate return riser for every coil or heater, the return risers not to be connected to each other until they are below the water line (see Fig. 1, at B).

3d. Main distributing pipes and distributing risers, with corresponding return mains and no return risers, the distributing riser carrying the water of condensation back through a relief to the main return pipe on the floor of basement (see Fig. 1, at C).

4th. (The single pipe job always a small one.) A single pipe for every heater, run directly from the top of the boiler to the heater, rising all the time in the direction of the heater, and of size sufficiently large that the steam passing to the heater to supply the loss from condensation will not interfere with the condensed water returning along the bottom of the pipe.

NOMENCLATURE.

The same names always apply to the same part of the circulation, no matter what the system. The word circulation means the whole distribution of pipe in any one job.

The Main Steam or Distributing Pipe.—The nearly horizontal live steam main, generally near the cellar ceiling (a' a'' a''').

The Main Return Pipe.—The nearly horizontal pipe on the floor, or thereabouts, of the cellar, for carrying the condensed water back to the boiler, b' b'' b'''.

The Steam Riser.—The pipe that carries the steam from the main distributing pipe to the radiators (c' c'' c''').

The Return Riser.—The pipe that carries the condensed water from the radiators to the main return (d' d').

The Steam Riser Connection.—The pipe that joins the main distributing pipe and steam riser (e' e').

The Return Riser Connection.—The pipe that connects the return riser with the main return pipe on the floor, and which has one or more T's in it below the water line to receive the steam riser relief (f f).

The Steam Riser Relief.—The pipe that connects the bottom of the steam riser with a T in the bottom of the return riser connection or main return pipe below the water line, to carry the water that runs down the steam riser into the return riser connection or main return pipe (g g).

Main Relief Pipes.—Connections between the main steam and return pipes, to throw the water carried from the boiler, and what is condensed in the main steam pipe, into the return main, also as an equalizer of pressure in the system (h).

Radiator Connections.—The pipes which run from the risers to the radiators, both steam and return, usually no longer than is necessary to get spring enough for the expansion of the risers (i i i).

A Relay.—The jumping up of a main steam pipe, with a main relief at the lower corner. This is to admit of keeping the main steam pipe near the line of the risers and the ceiling, and above the water line when the main lines are long (j).

Pitch.—Is the inclination given to any pipe, and in the steam mains of a low pressure apparatus should be down and away from the boiler (except in system No. 4), and if possible toward the boiler in the main return. (When the water and steam run in the same direction through pipes one source of noise is prevented.)

Water Line.—The general level of the water in the boiler throughout the apparatus. In some cases, where the boilers are at a distance, or in a sub-cellar, and the fitter wishes to gain the advantages of having returns and reliefs coming together below water, he makes an artificial water line by raising the main return pipes higher than his connections before he drops to the boiler. It is also necessary to bring a relief from the main steam pipe to this raised part of the return to prevent siphoning into the boiler.

HOW A BUILDING IS PIPED.

The steam-fitter should commence his work in a new building early, and architects and parties paying for the work should see that the contract for steam heating is let when the mason and carpenter work is let.

The risers are the first work done in a new building that proceeds in the ordinary way. If the builder and steam-fitter have an understanding at the commencement of the work, the former can leave the proper recesses in the walls exactly where the steam-fitter wants them. This will save much work to the fitter, and prevent the mutilation of the walls and be no expense to the mason.

Fig. 2.

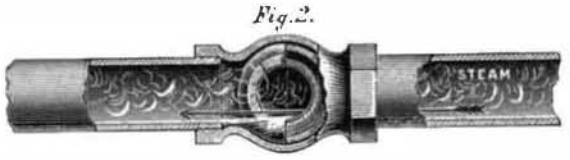
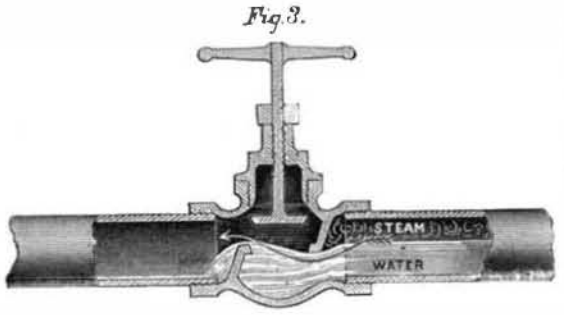


Fig. 3.



POSITION OF VALVE.

When the walls are up, the joists in their places, and the roof boards or roof on, the steam-fitter should then put up his risers.

If the building has not more than three floors to be heated it will do to rest the risers on a support at the bottom of the recess, but in higher buildings the risers should be suspended by the middle, so that the expansion may be divided. By allowing the riser to go both up and down from the middle the steam-fitter will be able to get along with shorter radiator connections, and will avoid the deep cutting of the floor joists.

The steam-fitter should avoid as much as possible taking two heaters from the same steam connection on a floor, and if it is unavoidable he should drop his returns down and bring them into the return riser some distance apart; or, better still, he should run them separately down below the water line (system No. 2), as it will prevent one heater from taking the air from the others.

If the risers are on the side of the room so that their outlets look between the joists, it is best to keep the T's about half way between the laths and the flooring, as this admits of nippling up, and leaves room for crossing the pipes, if required, below the floor. But if the outlets come at the side of the joists care must be taken that the T's come in the exact place. In a building with the risers resting on the bottom and all the expansion upward, the top outlet must be the lowest from the top of the joist, but only low enough to come within ¾ of an inch of the floor when expanded to their utmost; so also with the rest of the T's, according to their distance from the bottom of the riser.

With low pressure steam, the steam risers should be large

Fig. 1

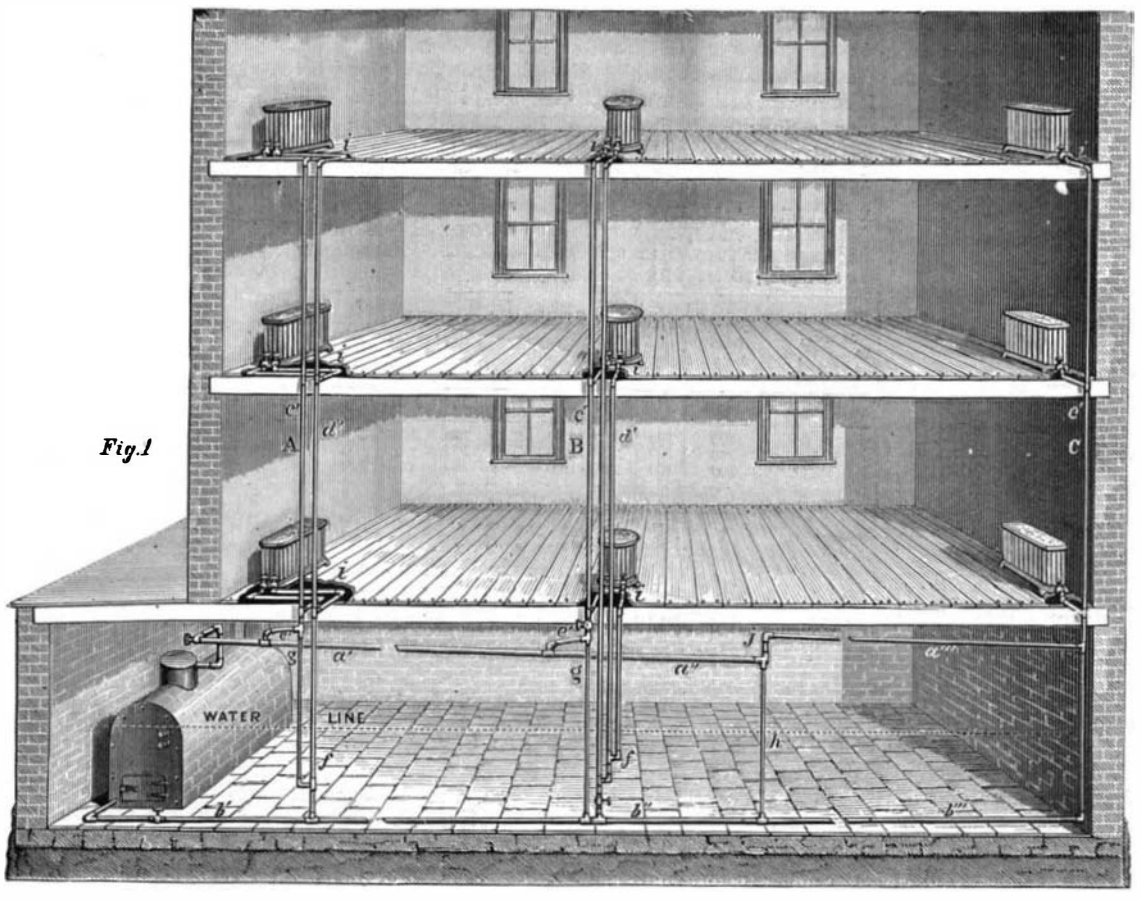


FIG. 1.—**SYSTEMS OF PIPING.**

The general practice with steam-heaters is to reduce one size of pipe for each floor. This rule is not arbitrary, but as architects' specifications usually call for it there are no objections, provided the pipe is large enough.

In system No. 1 the return riser is generally one size smaller than the steam riser, but it should never be smaller than a ¾ of an inch pipe.

In system No. 2, where many return risers are brought down in the same place, a 1 inch pipe for large heaters and a ¾ pipe for small ones are usual.

When the risers are all in the outlets should be plugged up with pieces of pipe, a foot or so in length, instead of the ordinary plug, as the latter is often difficult to get out when the plastering is done.

The risers should then be tested with cold water to from 100 to 200 pounds per square inch; this will prove if there are any cracked fittings or split pipe, and will save much time and annoyance when steam is gotten up.

The best way to cover a riser recess is with a board. Have grounds put on before the plastering is done, and screw a panel on afterward. Some architects require the recess to be plastered over, using slate or coarse wire cloth to hold the plaster. The latter makes the best work, as the heat from the riser will not crack it.

When automatic air valves are to be used on the steam heaters, a ⅜ inch pipe should be run in the riser recess, with an outlet at each floor to receive the air valve connection. The lower end of this air and vapor pipe should be taken to the nearest sewer outside of the sewer traps.

At this stage of the work, and before the floors are laid, the radiator connections should be run and firmly fastened in their places, making due allowance for the thickness of the furring on the walls, the plastering, and the baseboard. The radiator connections are usually run 1 inch or 1¼ inch for the steam connection, with a corresponding ¾ or 1 inch pipe for the return, according to the size of the heater; one and a quarter inch steam being enough for a radiator of 150 square feet of heating surface at low pressure, with a main of sufficient size.

When the radiator valves are threaded right-handed the elbows on the ends of the connections may be left-handed, to admit of connecting by a right and left hand nipple below the valve and between the valve and elbow, or *vice versa*.

When both valves are at the same end of the radiator, it is better to have the right and left nipples between the valves and the radiator. With this arrangement both valves of the radiator can be connected simultaneously, and the movement of the radiator will be in the direction of the valves. It also admits of the disconnection of a heater, after simply closing the radiator valves.

When the radiators are to be connected by any of the foregoing plans the connections can be firmly fastened, but not confined at their ends, that they may come in their exact places through the floors. The free ends of the connections should be closed with pieces of pipe long enough to come above the floors when laid. The air pipe should also be run at the same time and brought through the floor in close proximity to the position the air valve will occupy on the heater.

At this stage of the work the steam-heater usually waits until the floors are laid, plastering done, partitions set, and the basement graded.

Steam Mains.—Nearly all the success of the apparatus depends on its steam mains, their sizes, and how they are run.

A job has never yet been spoiled by having its steam mains large; still there should be a limit to their size, to prevent unnecessary expense and to keep the condensation and radiation of the distributing pipes at a minimum consistent with the actual requirements of the heating surfaces.

The size of steam mains depends on the pressure of steam to be used, the distance it is to be carried, the temperature of the exposure of the heating surfaces, and their extent. But as it is not my intention here to speak of steam used expansively, I shall endeavor to give sizes only for direct-return or gravity circulation apparatus.

Gravity circulation apparatus are of two kinds, low and high pressure. The low pressure apparatus depends on the difference of level of water in the return risers and the boiler for a circulation, irrespective of the steam pressure at any part of the distributing pipes; but the maximum pressure of steam to be carried must never exceed the equivalent of a difference in level of water between the water line of the boiler and the lowest part of the distributing main.

There is another condition under which this system will

work, and that is an increase of pressure sufficient to nearly establish a pressure throughout the apparatus, the difference in pressure at any part of the apparatus not to exceed the equivalent of a head of water between the water line in boiler and the lower part of the steam main. It is then a high pressure gravity circulation.

A well arranged gravity circulation should be made to work at any pressure, for with its heating surface properly proportioned it can be made to meet the exigencies of fall, winter, or spring weather by simply carrying a pressure suitable to the occasion.

To have the water of condensation return directly into the boiler under all conditions and pressures, the main pipes must be large enough to maintain the pressure of the boiler to within 1 or 1½ pounds in every part of the apparatus, and the water line of the boiler should be not less that 4 feet from the bottom of the horizontal distributing mains, at their lowest part, and that only in short mains, such as the generality of city business buildings and blocks. In large public buildings and others that have their boilers in outhouses, the difference between the boiler line and the mains should be all it is possible to get.

A main should not decrease in size according to the area of its branches, but very much slower, and should be rated by the heating surface and the distance it is to be carried. Neither should the main at the boiler be equal to the aggregate size of all its branches—an expression very much in vogue in specifications for steam heating.

Mains which have given the best results leave the boiler of sufficient size (calculated from practical results), and are reduced very slowly, if at all, until very near the end.

The area of the cross section of a 1 inch steam pipe is taken as unity for the sake of easy calculation in the rating of steam pipes, and the area of a 1 inch pipe in the main, at the boiler, to each 100 square feet of heating surface, mains included, is deduced from the size of the mains and heating surfaces of some of the best heated buildings in the United States, and has been the writer's rule for some years.

When the main steam pipe leaves the boiler it should, if possible, be carried high up at once, and have the stop valve at the highest part in the pipe, so that condensed water cannot lodge at either side of it when shut. This will prevent cracking at this part of the pipes when the valve is opened. If this arrangement cannot be carried out, and the valve has to be nippled on the dome of the boiler, or if there are several boilers and they have to be made interchangeable with regard to their use, there should be a relief of large size in the main, just outside the valves.

It is well to mention here that a relief which leaves the steam pipe must be brought into the return pipe in a position corresponding exactly to where it leaves the main; that is, when it comes from the outside of the main stop valve it should be taken to the outside of the main return valve. Otherwise, if an attempt is made to shut off, and both valves are closed, the water will back up and fill the apparatus. So also with all branch risers or connections; if there is a valve in the steam part, there must also be one in the return, and reliefs must leave the steam pipe and enter the return on corresponding sides of the respective valves.

From the highest point the main steam pipe should drop slowly as it recedes from the boiler (1 inch to 10 feet being a good pitch), that the course of the steam and the water may be in the same direction.

A main steam pipe should not run very close to the wall up which the risers go. There should be room enough for a riser connection 2 or 3 feet, and when the mains are long and the expansion much the distance should be increased.

The T's in the main, for the riser connections, are better turned up than sidewise, as by nippling an elbow to them you can get any desired angle, and should the measurement for the main be a little out it will make no difference. This arrangement also makes a good expansion joint if the mains have much travel.

Where the pipe reduces in size it is well to put in a relief in the lower side of the reducing fitting, as the water that is pocketed there by the large pipe pitching in the direction of the smaller one may be the cause of cracking and noise in the pipe. Some steam-heaters use an eccentric fitting in reducing, which brings the bottom of the pipe on the same line and makes nice work.

When it is necessary to have stop valves to the risers the steam-fitter often places them in the riser connections, with a valve also in the riser relief. This arrangement requires three valves, and also stops the local circulation and equalization of pressure.

It is better to use only two valves, one to the steam and one to the return riser, and place them a few inches up the riser, above the riser connection, which brings them also above the steam riser relief, saving a valve and lessening the chances for noise in the pipes.

In system No. 2, where the returns are carried down separately and collected together below the water line, the return valve should be below all such connections, and the steam riser relief should have a separate connection with the main return and have no valve. Straightway valves are best for risers.

The extreme end of a steam main should be connected by a relief with the main return, being in fact a continuation of the main down and into the return.

Stop valves in main steam pipes are either globe, angle, or straightway. When a globe valve is used it should be turned with its stem nearly horizontal, as shown in Fig. 2. The reason for this is obvious, when we consider that the water of condensation in any pipe runs along the bottom of it. When a globe valve is turned up, as in Fig. 3, the water in the pipe has to half fill it before it flows over the valve seat to pass along in the pipe. Not so when the valve is on its side for then the side of the opening of the valve seat is as low as the bottom of the pipe.

Neither should the stem of any valve be quite down to the horizontal position when it can be avoided. It should be raised enough (10 degrees) to prevent water from collecting in the threads of the nut and stem, and being forced out, by the pressure of the steam, through the stuffing box, making a constant dropping of water, which is almost impossible to hold with ordinary packing. Not so with dry steam; it can be held.

Globe or angle valves should be so turned in a heating apparatus that by simply closing the valve to be packed and its corresponding valve in the return, or *vice versa*, and waiting for the steam to cool down, the stuffing box or gland can be removed without the escape of steam. To do this it is necessary to have the pressure side of every pair of valves turned toward the boiler. What is meant by the pressure side of a valve is the under side of the disk.

Main Return Pipes.—In small apparatus (up to 3 inch steam pipe) they are usually run one or two sizes smaller than the corresponding steam pipe.

In returns, which are below the water line, or are trapped to give them an artificial water line and are consequently always full of water, there are no currents but the flow of the water toward the boiler. This style of return admits of the smallest piping, but good practice has placed it at one quarter the area of the steam pipe, for all conditions, for apparatus with larger than 3 inch steam pipe.

In dry returns—*i. e.*, which have no water line—there are local currents, often going in contrary directions, the water gravitating toward the boiler, the steam flowing to the heaters, and the air, the greatest source of annoyance to the steam-heater, going every place and any place except out of the air valve. This style of return is not much used, but in cases where there is no basement it cannot always be avoided.

One half the area of the steam pipe has been found in practice to give good results in dry return pipes.

Check valves are generally used in return pipes where they enter the boiler. Some steam-heaters leave them out on account of the back pressure they cause to the return water, but the practice is very much to be condemned when two or more boilers are connected, as an inequality in draught or the cleaning of a fire will make a small difference of pressure between boilers, causing the water to run from one boiler to another through the return pipes.

Check valves of large area in the opening, with a small bearing on the seat, can be made that will not give more than a quarter of a pound back pressure. If the valve is not ground and cleaned frequently when the job is new, there will be nothing but the actual weight of the disk to overcome.

It is sometimes convenient to reduce a return pipe where it enters the boiler for a short distance of its length. This may be done to a limited extent, bearing in mind the actual quantity of water to be admitted to the boiler in a given time.

A TABLE OF LINEAR EXPANSION OF STEAM PIPES (TO WITHIN 0·01 INCH) FOR EACH 100 FEET IN LENGTH, AT TEMPERATURES AND PRESSURES MOST FREQUENTLY REQUIRED BY THE STEAM-FITTER.

Temperature of weather when pipe is fitted.	Length of pipe when fitted.	Length of pipe when heated to 215° or 1 lb. steam.		269° or 25 lb. steam.		301° or 50 lb. steam		342° or 100 lb. steam	
Degrees Fah.	Feet.	Ft.	Ins.	Ft.	Ins.	Ft.	Ins.	Ft.	Ins.
0	100	100	1·80	100	2·26	100	2.53	100	2·88
32°	100	100	1·54	100	1·98	100	2.26	100	2·61
64°	100	100	1·20	100	1·73	100	2·	100	2·35

Astronomical Notes.

OBSERVATORY OF VASSAR COLLEGE.

The computations in the following notes are by students of Vassar College. Although merely approximate, they will enable the observer to recognize the planets. M. M.

POSITIONS OF PLANETS FOR DECEMBER, 1879.

Mercury.

On December 1 Mercury rises at 8h. 37m. A.M., and sets at 5h. 26m. P.M.

On December 31 Mercury rises at 5h. 47m. A.M., and sets at 3h. 6m. P.M.

Mercury should be looked for during the last week of December, before sunrise, a few degrees north of the point of sunrise.

Venus.

Although less brilliant than in November, Venus will be very beautiful in the early morning through December.

On the 1st Venus rises at 3h. 9m. A.M., and on the 31st at 3h. 54m. A.M.

It will be at its greatest western elongation on the 3d. On the 10th of December Venus and the narrow crescent of the waning moon will rise nearly at the same time, Venus being north of the moon. A telescope of three inches aperture will show that the disk of Venus, like that of the moon, is seen only partially enlightened by the sun. It will be half illuminated in December.

Mars.

Mars was in its best position in November, but it will be more likely to be observed in December, as it comes to the meridian during the evening and precedes the beautiful group of the Pleiades.

On December 1 Mars rises at 3h. P.M., and sets at 5h. 8m. the next morning.

On December 31 Mars rises at 59m. after noon, and sets at 3h. 13m. the next morning.

A small telescope will show peculiar markings upon Mars; it is, however, less interesting then Jupiter and Saturn, as its newly discovered moons can be seen only by means of the largest telescopes.

On the evening of December 23 the moon will be seen to draw near to Mars, and after midnight to pass east of the planet, Mars being about 3° lower than the moon in altitude.

Jupiter.

Jupiter is still the great light among the planets, yet is setting earlier, and is perceptibly more remote from us.

On December 1 Jupiter rises at 26m. after noon, and sets at 11h. 7m. P.M.

On December 31 Jupiter rises at 10h. 38m. A.M., and sets at 9h. 31m. P.M.

If we take the hours from 8 to 10 P.M. for observing Jupiter we shall not see the first satellite during a part of that period on the 5th, 14th, and 21st, because it is behind the planet; it is unseen because in transit across the planet, December 6 and December 13; on the 30th it reappears from the shadow, having been eclipsed.

The second satellite, the smallest, is not to be found at some part of the period from 8 P.M. to 10 P.M., because behind the planet December 1, and in transit across the planet December 10 and 17.

The third satellite reappears from transit December 9, and disappears December 27, by passing into the shadow of Jupiter.

The fourth satellite will not be seen on the evening of December 31, because in Jupiter's shadow. The moon will pass east of Jupiter on the evening of December 18.

Saturn.

With a powerful glass Saturn is even more interesting than Jupiter; with an ordinary glass its ring and the two larger satellites can be seen.

On December 1 Saturn rises at 1h. 51m. P.M., and sets at about the same hour the next morning.

On December 31 Saturn rises at 11h. 53m. A.M., and sets 3m. after midnight.

Between December 18 and December 24 the moon passes Jupiter, Saturn, and Mars by its motion in orbit; it passes Saturn before noon of the 21st. On the evening of the 20th Saturn will be east of the moon; on the evening of the 21st Saturn will be west of the moon.

Uranus.

On December 1 Uranus rises at 11h. 27m. P.M., and on the 31st at 9h. 29m. P.M.

Uranus is near the star Lambda Leonis, 2¼° nearer the horizon when that star culminates, or between 4 and 5 A.M. during December.

Neptune.

Neptune comes to the meridian at 9h. 50m. P.M. of December 1, and at 7h. 50m. December 31.

Its position is not much different from that of Mars. On the 1st Neptune is 4° south of Mars, and passes the meridian 14m. earlier. On the 31st Neptune is 15m. earlier than Mars in coming to the meridian, and 5° south of Mars. Only a powerful glass will enable the observer to distinguish it from a fixed star.

Relation of Masters and Apprentices.

We have often thought that if masters properly comprehended the relation they sustain to their apprentices and employes, their pecuniary interest would not only be greatly enhanced, but that a positive good would be rendered to every branch of industry in which they are engaged.

The first duty of a master should be to present in himself an example for imitation in the elements of industry, morality, system, and the other attributes which constitute a superior mechanic or workman. They should, moreover, observe and study the dispositions and minds of their apprentices, with a view of conciliating their regard and confidence, and through this means to establish a free and familiar intercourse, and render the task of instruction and development more simple and easy. As the apprentice advances in knowledge and skill, suitable evidences of appreciation and encouragement should be given them. This will stimulate their ambition and exertion, and create among them a worthy spirit of emulation.

Where the character of an apprentice is such as to require a tight rein upon his actions, and the deprivation of privileges, and other suitable punishments for idleness and misconduct, care should be observed that these curbs and punishments do not descend into such acts of tyranny as will destroy the spirit and ambition of the youth, and render him obstinate, unruly, and beyond all future influences of excellence and good. Besides a thorough instruction in his trade or profession, and a sound and healthy education to otherwise render him fit for his social position in life, it should be the aim of a master to instill into his pupil all the scientific and other knowledge possible, even should such knowledge have no direct bearing upon the business or trade in which he is engaged. Such acts of interest, kindness, and confidence as these, and others of a corresponding character, cannot fail to produce the most marked beneficial results upon the interests of the master, and the happiness and future of the grateful apprentice.