means the sanitary engineer appointed by the council to carry out the provisions of this by law, or his representative.

Sec. 6. Any person contravening any of the provisions of this by-law shall be liable to a fine, and in default of immediate payment of the said fine, and costs, to an imprisonment—the amount of said fine, and the term of said imprisonment to be determined by the recorder's court, *at its discretion;* but the said fine shall not exceed forty dollars, and the term of imprisonment shall not exceed two calender months; the said imprisonment, however, to cease at any time before the expiration of the period fixed upon by the recorder's court, on payment of said fine and costs; and where the infraction is continuous, such infraction during each day, shall constitute a separate offence.

THE DIFFERENCE IN AMOUNT OF RADIATION REQUIRED IN BUILDINGS OF GOOD AND POOR CONSTRUCTION.*

To illustrate the subject before us I will recite my experience in several buildings. In the fall of 1879 I placed a low pressure steam heating apparatus in a building designed for a home for old ladies. Many of the rooms were small, and in order to warm them without question a radiator was placed in each room. Knowing that a high temperature would be agreeable, the calculation was made that one foot of radiation would warm 40 cubic feet of air. This we considered very liberal when the fact that we used the Gold sheet iron radiator is taken into account. We were, however, doomed to a very serious disappointment, as the temperature in the rooms on the windward side of the house frequently fell to 50 degrees, and sometimes even below, during severe cold and windy weather. After reconsidering all the conditions we determined to add a large percentage of radiation, which was done, and the building has been thoroughly warm ever since. The amount of radiation added in many of the exposed rooms was from 50 to 100 per cent. over that originally supplied. To my mind the rooms in this building are very uncomfortable, for the excessive amount of radiation required to maintain the temperature produces a very disagreeable condition of affairs, together with the excessive loss of heat through the thin walls and many air leaks. It was soon found that although the ratio of radiation was very excessive under the existing conditions the condensation was very rapid, and more boiler power was required to maintain the steam pressure. Consequently an additional boiler was supplied, at the expense of the heating contractor, which gave plenty of generating power, but all this was accomplished at a heavy proportional loss to the contractor. To my mind as I review the entire matter I find that the original calculation for the boiler and radiating surface were correct providing the building in question had been ordinarily well constructed. But from subsequent surveys I conclude that the architect and building contractor produced about as poor a specimen as it was possible to do and have it stand up as a public building. The result is that the amount of fuel needed to warm the building is enormous.

I have in my mind another building which belongs to one of our popular colleges. The building was constructed in 1872. The location was on the brow of the hill where the front was exposed to the force of the northwest winds. It was the intention of the heating contractor to make this building very warm, and all calculations were made with this object in view. After the apparatus was complete and the weather became cold it was found that many of the small rooms in the west front did not warm to the required temperature, and an investigation was made to determine the cause if possible. We referred to our calculations as to boiler, piping, radiating surface, etc., and found that the apparatus was constructed according to our calculations; nevertheless we were confronted with a number of cold rooms. We finally determined that the only way to satisfy ourselves was to live in the building and keep a record of the temperature, both in the rooms and outside. While this was in progress I visited the building one very windy day and in entering some of the west rooms I was surprised to find that the hall door would be pulled away from me and shut with a report like a gun. I supposed at first that the windows were open, but examination showed that they were closed as tight as possible considering their construction. but the air was constantly driven through the brick walls of the building, in fact, the volume of air forced into the room was so great that the hall door was opened with difficulty. The radiators in these rooms were liberally increased and the warming of the building has been very satisfactory to its occupants. The heating contractor in this case did not meet with a decided loss, as a very liberal allowance for the exposure of the building had been made in the original calculations.

Another striking case comes prominently before me. About eight years since I placed the heating in one of our State normal schools. The building was in a very exposed location and the radiating surfaces were very carefully apportioned in order to fully meet all conditions. One large class room, containing about 100,000 cubic feet, was provided with one square foot of radiation to 40 cubic feet of space. This was thought to be excessive at the time but we wished to do the work right the first time and not have any alterations or additions to follow the work, so the full amount of radiation was supplied. When the weather became severe this room was very cold and radiating surface was added at various times until the ratio was brought up to 1 to 18 and the desired temperature secured. The larger part of the radiation was direct, in fact, all radiation which was added was direct. I found that while standing in the room during a severe northwest wind, you could feel the wind on your face as it came through the wall of the building. In the illustrations cited the buildings were very carelessly constructed, the architects in charge giving very little attention to the minor details which have the most important bearing in the comfortable use of the building.

I will now call your attention to the reverse of the conditions named above. Last year I contracted to place a small hot water apparatus in an old residence which was being altered slightly and converted into a small apartment house. The building was not badly exposed, so the calculations where based on a moderate amount of radiating surface. The apparatus was complete in the fall and the tenants moved in. The fire had not been started but a few days when there was a general complaint of too much heat, especially in the bedrooms. I find that the latter contain about 1,500 cubic feet and a radiator of 32 square feet was used to supply the heat. Our advice was to shut the valve in the radiator and run the water at a lower temperature, and when very cold weather came they would be very happy with nicely warmed rooms. Our suggestions were partly followed, but the complaints of over heating were almost constant and after passing partly through the winter both owner and tenants demanded that the raditors be removed from all the bedrooms at least. This was done and there remained in these rooms a riser of 1¼ pipe, which contains about four and a half square feet of radiation surface. In a room of 1,500 cubic feet, or a ratio of 1 to 333. The bedrooms being outside rooms, I have never had the opportunity to examine this house but there is no doubt as to its good construction. I might further say that I am advised that the temperature of the water is kept down to 140 to 160 degrees in the coldest weather.

A few years since I built a small stable. Its dimensions are 24 by 36 feet on the ground. The ground room is used as a carriage room, horse stalls, harness room, etc. In practice the floor is commonly used as one room; above is a hay loft, with a room for the driver over the harness room. To my mind it is desirable to keep the stable moderately warm through the winter and to accomplish this with a moderate outlay in apparatus and fuel. Over the horse stall is a ventilating pipe running through the roof, this pipe is 12 inches in diameter and is always open summer and winter. Usually the air is going through it at a high velocity. There is no special provision to bring air into the stable, but the doors and windows are ordinarily well fitted, and there are large leaks about the entrance to the carriage room which has a sliding door about 9 feet square and opens to the north. In using the stable no difficulty was found to warm it to 60 degrees in the most severe weather, and an ordinary globe stove was used with a grate 8 inches in diameter. The amount of fuel used per season is between three and four tons. The stove pipe passes through the driver's room and heat given out by the pipe maintains a comfortable temperature in that room. I believe this stable is more comfortable in summer and winter than the average stable, although many of them may be much more expensive in construction. The stable is built of wood. The frame is balloon style, the upright stands are 2 by 4 inches, set about 16 inches between centers. On the outside of these studs I placed a course of rosin-sized building paper and one thickness of coved siding. In order to prevent the buckling of the paper at the laps, and to prevent a rapid change or circulation of air between the studs, I placed a 2 by 4 inch girth lengthwise (between the upright studs) on the sill: then, once in three feet, cut in a 2 by 4 inch as an additional girth. The paper being a yard wide abutted on this extra girth which held the edges tight and prevented the circulation of air from cellar to hay loft, and *vice versa.* On the inside of the carrage rooms on the ground floor, as well as other rooms on the ground floor, a course of building paper was used and ceiled over with ½-inch narrow Canada pine for a finish. Under the roof of the hay loft was laid a course of building paper also on the ceiling of carriage room before the ½-inch wood ceiling was laid. At the top of carriage room where the studs and joist join, I stopped off with boards to prevent the circulation of air. The idea of using the cross girths once in three feet and building paper on the inside of the walls was very amusing to the old carpenters employed on the work, but it is very satisfactory in a cold day and equally so in hot weather, the building being much more comfortable than many dwellings which are built at a much greater cost per cubic foot. It will be noticed that the stable here described is of very inexpensive construction and would be very cold in winter and hot in summer except for the succession of dead air spaces in the walls, cove siding being one of the poorest materials for keeping the wind from penetrating a building. Believing that I was correct in theory I determined to carry out my ideas more carefully in the construction of a house two years since. This house to which I will refer stands alone fully exposed on all sides on high ground, in Syracuse, where the temperature frequently falls below zero, and occasionally 15 to 20 degrees below zero.

It is constructed of wood and is comparatively inexpensive. The frame is what is known as baloon with slight modifications. On the outside of the frame are placed hemlock boards planed on one side, and over the hemlock is placed a course of heavy building paper, care being taken to leave no bare spaces, or uncovered knot holes; also that the paper fitted properly around all corners, windows and door frames. A 2 by 4 was nailed to the sill to prevent the air from cellar going to the attic or *vice versa.* Once in three feet a cross girth 2 by 4 inches was cut in between the upright studs to make a dead air space in the walls. This was also done in the partitions. At the ceiling of each story, a board to fill the space between the joists were inserted: said boards were covered with building paper. Over the partitions in the center of the house a stop off was inserted in a similar manner to prevent the air from passing from side to side of the house and cooling the ceilings of the various rooms. The roof boards were covered with paper before the shingles were laid. Every point was carefully looked after to prevent air leaks, the object being to get dead air spaces in all the walls as far as possible to do this. The next point was to install a good warming apparatus, and after having the old saw about the shoemakers' wives and blacksmiths' horses handed to me several times, I determined to erect a heating apparatus which would surely warm the house every day. I therefore placed in the house a No. 6 Bate's self feeding boiler containing 103 square feet of fire surface. This boiler is brick set. Allow me to speak of a peculiarity of this boiler, quite different from many which are advertised. It does not save any coal. They will burn all you fire into them, but if the firing is done with any reason the boiler will give you an equivalent in heat for every pound of fuel it consumes. The house in question being three stories it was decided to make a combination apparatus, i. e., hot water and steam, using hot water stacks for the five principal rooms, and steam radiators for bath, back hall and the small bedrooms The hot water was circulated from the water line, the boiler set in the usual way for carrying steam, with automatic water feeder, automatic draft door, etc. I placed in the house, which contains about 16,000 cubic feet of air space, 457 square feet of radiation, equal to one square foot to 33 cubic feet of space to be warmed Of the above 350 square feet was in the indirect hot water stacks and 127 square feet distributed in seven small radiators. For ventilation I built one chimney stack which connects conveniently to most of the rooms. In this chimney stack I placed eight tile flues made of vitrified pipe without hubs and all eight inches in diameter except the flue for the fire place in dining room which is 10 inches in diameter. These fires are used as follows: one for steam boiler, one for laundry stove, one to ventilate laundry (being three in basement), one for fire place, one for range, and one for hood over range to take off heat and vapor from cooking (being three on ground floor). On the second floor there is one flue from the large bedroom at the base of which is set a Franklin stove, and the other and eighth flue in the back hall. The bedroom being several feet from the chimney has a separate flue of tin and galvanized iron extending through the roof independently, with a globe ventilator on top. Every test made shows each flue carrying out large amount of air, and those flues to which fires are connected are very satisfactory; in fact, they never fail to draw, and the course or velocity of the wind seems to make no difference, so it is evident that a rapid change of air is going on constantly.

As to results. When the thermometer registered 5 degrees below zero during the past winter we used one stack of pin radiators in the reception hall. Said stack contains eight sections. The register over the other stacks was kept closed, a radiator of 16 square feet in back hall of second floor was filled with steam, and a radiator of 18 feet on third floor was partly filled, equal to ten square feet, or in all 108 square feet in active operation in severe weather. There is no doubt we receive some benefit from the stacks where the registers were closed as there is a small percentage of leakage through the registers, and some heat given off by the tin flues running to the upper rooms. If only 108 feet were used the ratio would be 1 to 135. After having several cold days and demonstrating the fact that the amount of radiation was greatly in excess of the amount which could possibly be used, radiators were removed from the house, to the amount of 86 feet of direct radiation and 60 feet of indirect, the latter being the stack placed to warm the drawing room and was not used, as the room was thoroughly

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