

BUG DISINFESTATION IN A PRISON

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(With 3 Figures in the Text)

The bed-bug finds an almost ideal environment in a prison, which is centrally heated in winter, and in which it has good harborage in the wooden cell furniture and an easily available food supply at night. Under such favourable conditions, bugs increase about seventy-fold in a year. It is therefore no mean achievement to obliterate bugs from an infested prison while the prison is still occupied, and is, I think, worth putting on record.

A preliminary survey showed that bugs were present only in the cells in which prisoners slept. The cell walls are pointed brick work, painted up to 4½ ft. and the remainder of the wall and the ceiling is limewashed. The cell door is lined on the inner side with metal plating. The furniture of a cell comprises a wooden bed board (three planks with spacing between them, joined together by three transverse battens), a wooden table, chair and washstand. A row of wooden pegs for hanging towel, clothes, etc. is fixed to the cell wall. All the wood is unpainted.

For many years the infestation was kept more or less under control by methods now regarded as ineffective, but during the war years, with increased numbers of prisoners, and reduced staff, the infestation grew gradually worse. Inspection showed a large number of bugs in the wooden cell furniture, a much smaller number in the cell walls, especially around the door frames, and very few in the bedding. A simple method of dealing with the infestation would have been hydrogen cyanide fumigation of the cells and furniture, but this was impracticable as the prisoners could not be evacuated.

I had carefully studied the very instructive report of Dr J. L. Burn (1945), published towards the end of 1945 on what is often referred to as the 'Salford House experiment', in which a bug infested common lodging-house was cleared of bugs by means of D.D.T. alone. The sleeping accommodation in a prison is in many ways similar to that in a common lodging-house, but compared with Salford House there were more bugs in the prison, and more wooden furniture in which they could hide. The metal-lined prison cell door presented special difficulties. It was convenient to consider separately three items needing treatment, namely, (a) the cell itself, (b) the cell furniture, and (c) the bedding. D.D.T. spraying was the ideal choice of treatment

for the cells and in addition it provided protection against reinfestation for several weeks. Hydrogen cyanide fumigation seemed to be the best line of treatment for the cell furniture which contained the largest number of bugs and eggs. It has adequate penetrating power which enables it to get to bugs and eggs behind the metal plating of a cell door. These door plates have unusually deep crevices and bugs penetrate up to 10 in. into them. Compared with hydrogen cyanide D.D.T. is slow, and it is known that some bugs may remain inactive in crevices for many weeks and thus not get into contact with a D.D.T. deposit. There remained only the bedding to consider, and it was efficient to treat it in a hot-air disinfector. The wooden furniture, if treated by hot air, would probably have warped, and from a security angle warped cell doors could not be contemplated. Treatment of bedding with hydrogen cyanide was contra-indicated owing to the readiness with which hydrogen cyanide is absorbed by fabric and subsequently driven off by the warmth of the body.

PLAN OF ACTION

The debugging operation started in April 1946 and was completed by the following October. Prisoners were employed for the cleaning of cells and carrying furniture to and from the Pest Destruction building. The D.D.T. spraying was done by hospital officers who took the usual precautions. They showed no signs of any toxic effects from the use of the spray. The cyanide operators were two temporary prison officers who were instructed by an experienced operator from Fumigation Services, Ltd. After 4 days' instruction they were considered competent to work without further supervision.

Two landings, roughly 100 cells, were kept empty. The door was unhinged, and the row of wooden pegs removed from the wall. These and the cell furniture and bedding were taken away to the Pest Destruction building. The lime was scraped from the walls and ceiling and all crevices were stopped with cement. The cell was then redecorated but instead of limewash a mixture of size and Ceilingite (which filled in smaller crevices) was used. Very little would be gained by incorporating D.D.T. in the Ceilingite, as the deposit from a D.D.T./kerosene spray leaves more D.D.T. available for contact

action. The floors and walls for about 2 ft. up from the floor were then sprayed with a 5% D.D.T./kerosene solution and places where bugs were likely to hide, such as around the framework of the door, received special attention. In preparing the solution cyclohexanone was used to increase the solubility of the D.D.T. powder. It took about 8 oz. of the solution to spray a cell, and a fine deposit of D.D.T. crystals was evident after spraying. About 100 sq. ft. were sprayed in each cell, resulting in 106 mg. D.D.T./sq. ft. In a Ministry of Supply monograph (1946) it is stated that against bed-bugs '100-150 mg. D.D.T./sq. ft. gave a toxic surface for 10 weeks'. Finally, a notice was put in each cell warning prisoners not to scrub the cell or furniture and not to make holes in the walls. Prisoners were allowed to scrub cell and furniture 3 months after spraying.

While the cell itself was being treated, the furniture, door and bedding were being treated in the Pest Destruction building.

PEST DESTRUCTION BUILDING

This was provided by alterations to an isolated disused building, which is roughly 30 × 12 ft. and consists of a boiler house, a hot-air disinfector and a cyanide chamber (Fig. 1). A high wire fence all round the building prevents unauthorized persons from entering the 'risk' area while cyanide is being used. The hot-air disinfector (Fig. 2) is of 1500 cu. ft. capacity and contains metal racks for hanging blankets, etc. Around the inside walls are gilled steam pipes about 3 ft. from the floor. The hot air is kept in continuous circulation by means of fans to ensure a quicker rate of heating and to prevent layering. The bedding is subjected to a temperature of 170° F. for 2 hr.

The cyanide chamber (Fig. 2) is of 1125 cu. ft. capacity. All controls are operated from outside. To reduce absorption of the hydrogen cyanide, the walls and ceilings were given three coats of paint and the floor covered with a specially hardened cement. Liquid hydrogen cyanide is poured from outside through a cast-iron pipe (Fig. 3), 4 in. in diameter, on to a metal tray on the floor of the chamber, and the outside opening of this pipe is closed by a gas-tight metal cover. The temperature inside the chamber is then raised to 100° F. by means of steam pipes (a thermometer showing on the outside registers the temperature in the chamber).

Liquid hydrogen cyanide is volatile at ordinary temperatures and it boils at 78.8° F., i.e. the temperature on a warm summer day, but as it volatilizes it uses up heat and cools the remainder of the liquid. This raising of the temperature to 100° F., which to some may seem unnecessary, has I think advantages. It assists in volatilizing the liquid hydrogen cyanide and it greatly assists desorption of hydrogen

cyanide during the ventilation period. It also seems to induce or compel the bugs to come out from the cracks and joints of the furniture, and they become very lively in response to the heat before they succumb to the cyanide, and fall off the furniture on to the floor where numbers of them are found dead afterwards.

The concentration of hydrogen cyanide which is lethal to bugs for various exposure periods is not, as far as I know, accurately known but it is believed that as low a concentration as 1 oz./1000 cu. ft. (0.09% by volume) is lethal to bugs exposed to it for 6 hr. The hydrogen cyanide chamber which has a capacity of 1125 cu. ft. received for each fumigation a dose of 16 oz. of liquid hydrogen cyanide, corresponding to a nominal concentration of 14.2 oz./1000 cu. ft. (1.17% by volume). I had no facilities to estimate the concentration by analysis, but after allowing for some absorption and perhaps slight leakage of the fumigant, the concentration in the chamber at the start was probably about 0.89% by volume. The furniture was put in the cyanide chamber at 5 p.m. and remained there till 9 a.m. the following morning, that is an exposure to the fumigant for 16 hr. Such a long exposure may not have been necessary, but it was convenient to unload the chamber in the forenoon and load it in the afternoon. To clear the chamber of the fumigant there is a trap-door (Fig. 3) in the ceiling (closed during fumigation and open during ventilation). Above this is an electric extractor fan at the base of a 12 ft. ventilator stack. Gas-tight hinged flaps at the bottom of the chamber door act as air inlets when opened. Though hydrogen cyanide is lighter than air and natural ventilation was being assisted by an extractor fan there were still pockets which remained undisturbed by the extractor fan and from which hydrogen cyanide was removed rather slowly. To prevent this, fans were fitted to keep the fumigant in the chamber in continuous circulation and the fans were kept on during ventilation, which took about an hour. The Benzidine acetate-copper acetate test was used by the operators to detect the presence of any hydrogen cyanide in the air where they worked, and anything over a concentration of 0.003% by volume was regarded as possibly dangerous. This test gives only a rough estimate of the amount of gas present, but by comparing the colours of the test papers used with the set of standard colours described by Page, Lubatti & Gloyns (1939), it is possible to say when it is safe to take off the special gas-mask. Meteorological conditions had to be taken into account as the desorption and dispersal of hydrogen cyanide is influenced by them. After treatment in the cyanide chamber the furniture was aired for 24 hr. in an open covered shed before it and the treated bedding were put back in the treated cells.

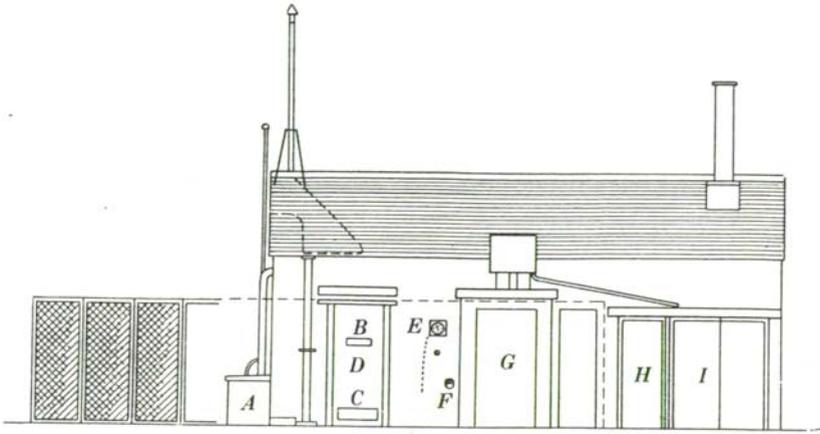


Fig. 1. Pest destruction building. Scale: $\frac{1}{2}$ in. = 1 ft.

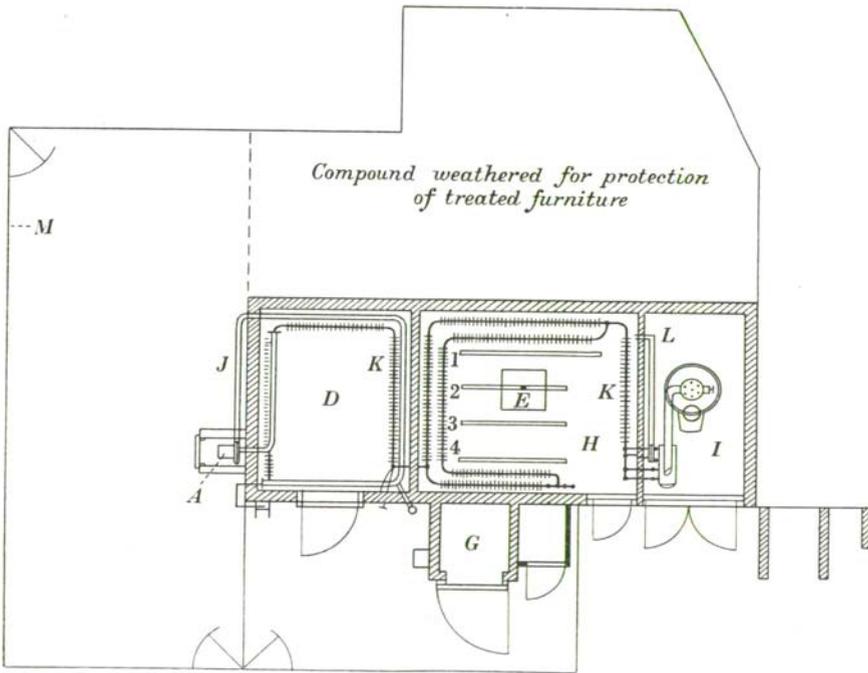


Fig. 2. Plan of pest destruction building. Scale: $\frac{1}{8}$ in. = 1 ft.

Key to Figs. 1 and 2

- A. Gas-tight motor house
- B. Glass inspection panel
- C. Air inlet flaps
- D. Cyanide chamber
- E. Thermometer

- F. Induction pipe
- G. Cyanide store
- H. Heat chamber
- I. Boiler house
- J. Circulation of fumigant

- K. Steam pipes
- L. Circulation of hot air
- M. Wire Fence
- 1—4. Racks

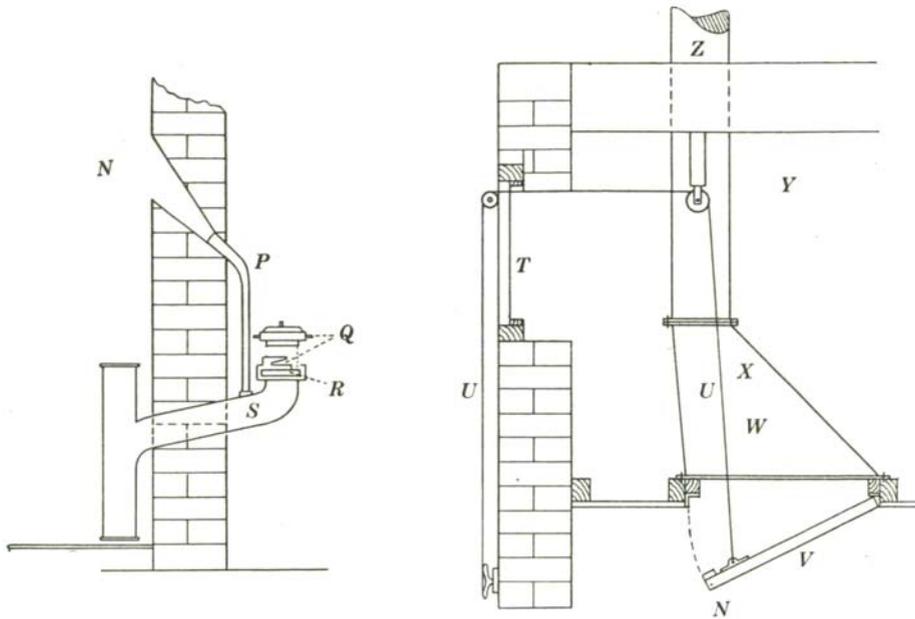


Fig. 3. Sectional elevation of gas charging plant. Scale: $\frac{1}{2}$ in. = 1 ft.

Key to Fig. 3

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|---------------------------------|---|--|
| N. Cyanide chamber | S. Cast-iron pipe | W. Extractor motor and fan inside trunking |
| O. Metal tray | T. Roof access door | X. Trunking |
| P. Ventilation of pipe | U. Pull cord for opening and closing ventilating trap | Y. Roof space |
| Q. Locking pin and slot for cap | V. Ventilating trap | Z. Ventilating stack |
| R. Rubber bonding | | |

RESULTS OF THE TREATMENT

The infestation was heavier than I had anticipated. After each fumigation hundreds of dead bugs were found on the floor of the cyanide chamber. On a number of days they were counted and on an average there were 400 after each fumigation of the furniture of ten cells. It is known that bugs apparently dead may revive later on, so samples were kept for 24 hr. and none was found to revive. Different articles of furniture were frequently examined before treatment, and it is interesting to note that up to the middle of April very few fresh eggs or nymphs were found and the majority of live bugs seen were adults. Normally, the bug season is from April to September. I was surprised that with central heating there were not more signs of winter activity. After April there were fresh eggs and nymphs as well as adults. On five occasions in July, bugs were reported in a cell within a fortnight after spraying with D.D.T., but these bugs were in a dying condition and all of them died in a day or two. After treatment each piece of furniture was branded with a hot iron to prevent

prisoners exchanging an article of treated furniture for an untreated one, and in that way reinfesting a cell.

It was evident that large numbers of bugs were being killed and as the egg is more vulnerable than the bug to cyanide I might have assumed that if all bugs were killed, so also were the eggs. However, I decided to confirm this. The bug's egg which is $\frac{1}{20}$ in. long by $\frac{1}{80}$ in. broad, is laid in crevices and it is attached to the surface on which it is laid by a quick-drying cement exuded by the female at the time of laying. To collect eggs from cell furniture without damaging them is a very delicate process. Dr Busvine kindly supplied me with fertile bug and lice eggs from his laboratory. Samples of eggs were put in the hot-air disinfectator for an hour at 170° F. and in the cyanide chamber for the usual fumigation time given to the furniture. Afterwards I incubated these bug eggs with a control sample of untreated eggs at 77° F. and the lice eggs in a similar way but at 86° F. None of the treated eggs hatched out. The control samples hatched out in a fortnight.

GENERAL COMMENTS

Care was taken to comply with the Hydrogen Cyanide (Fumigation) Regulations made by the Secretary of State under the Hydrogen Cyanide (Fumigation) Act of 1937. A 'Novox' Resuscitation apparatus was always kept ready for immediate use, but it was never found necessary to use it. It was tested periodically to see that it remained in good working order and to ensure that both cyanide operators were familiar with its use in case of an emergency.

The success or otherwise of a disinfection such as this in a prison depends almost entirely on attention to detail, e.g. to ensure that no article of cell furniture which might be infested is left untreated and that once treated it is not reinfested. The bug, unlike the louse, will not remain in a mattress or blanket if better harbourage such as that in a bed board is accessible. However, a few

bugs were found behind the buttons of mattresses and a few were found dead on the floor of the hot-air disinfector after mattresses had been treated. No bugs were found on blankets or sheets. This indicates that the mattress alone needed treatment, and I am inclined to think that D.D.T. spraying of the mattress would be sufficient in any future disinfections.

The cost of expendable materials, which was much less than I had anticipated, was: liquid hydrogen cyanide £55. 5s., D.D.T. £11. 4s., cyclohexanone £10 and kerosene £8. 12s.

In conclusion, I should like to express my thanks to J. R. Busvine, Esq., Ph.D., B.Sc., F.R.E.S., of the Ministry of Health (Entomological Laboratory), and A. B. P. Page, Esq., Ph.D., D.I.C., of Imperial College of Science (Department of Zoology and Applied Entomology), for valuable co-operation and advice.

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(MS. received for publication 2. I. 47.—Ed.)