

Correspondence.

Oil-Burning Boilers—How to Start the Fire.

To the Editor of the Scientific American:

In your issue of October 22 you quote from *Iron* a description of the method of using oil for fuel in boilers; and it is there stated that the furnace is primarily started with coal until a sufficient steam pressure has been reached in the boiler to start the oil-burning apparatus. When a boiler or furnace has been properly arranged for burning oil, it is not fitted to burn any other kind of fuel. Hence the inconvenience of generating steam with other kinds of fuel is very marked, and can be obviated and much improved by connecting an air pump to be operated by hand. The pump can be connected either to the boiler or direct to the burner. I know of the former method being used satisfactorily.

BEN. HILL.

Tiona, Pa.

Experiments on the Sense of Smell in Dogs.*

I once tried an experiment with a terrier of my own, which shows, better than anything that I have ever read, the almost supernatural capabilities of smell in dogs. On a bank holiday, when the Broad Walk in Regent's Park was swarming with people of all kinds, walking in all directions, I took my terrier (which I knew had a splendid nose, and could track me for miles) along the walk, and, when his attention was diverted by a strange dog, I suddenly made a number of zigzags across the Broad Walk, then stood on a seat, and watched the terrier. Finding I had not continued in the direction I was going when he left me, he went to the place where he had last seen me, and there, picking up my scent, tracked my footsteps over all the zigzags I had made, until he found me. Now, in order to do this, he had to distinguish my trail from at least a hundred others quite as fresh, and many thousands of others not so fresh, crossing it at all angles.†

The object of the experiments about to be described was that of ascertaining whether a dog, when thus distinguishing his master's trail, is guided by some distinctive smell attaching to his master's shoes, to any distinctive smell of his master's feet, or to both these differences combined.

I have a setter bitch, over which I have shot for eight years. Having a very good nose, she can track me over immense distances, and her devotion to me being very exclusive, she constituted an admirable subject for my experiments.

These consisted in allowing the bitch to be taken out of the kennel by some one to whom she was indifferent, who then led her to a prearranged spot from which the tracking was to begin. Of course this spot was always to leeward of the kennel, and the person who was to be tracked always walked so as to keep more or less to leeward of the starting point. The district—park lands surrounding a house—was an open one, presenting, however, numerous trees, shrubberies, walls, etc., behind which I could hide at a distance from the starting point, and so observe the animal during the whole course of each experiment. Sundry other precautions, which I need not wait to mention, were taken in order to insure that the bitch should have to depend on her sense of smell alone, and the following are the experiments which were tried:

1. I walked the grass lands for about a mile in my ordinary shooting boots. The instant she came to the starting point, the bitch broke away at her full speed, and, faithfully following my track, overtook me in a few minutes.

2. I set a man who was a stranger about the place to walk the park. Although repeatedly put upon his trail by my servant, the bitch showed no disposition to follow it.

3. I had the bitch taken into the gun room, where she saw me ready to start for shooting. I then left the gun room and went to another part of the house, while my gamekeeper left the house by the back door, walked a certain distance to leeward in the direction of some partridge ground, and then concealed himself. The bitch, who was now howling to follow me, was led to the back door by another servant. Quickly finding the trail of the gamekeeper, she tracked it for a few yards; but, finding that I had not been with him, she left his trail, and hunted about in all directions for mine, which, of course, was nowhere to be found.

4. I collected all the men about the place, and directed them to walk close behind one another in Indian file, each man taking care to place his feet in the footprints of his predecessor. In this procession, numbering twelve in all, I took the lead, while the gamekeeper brought up the rear. When we had walked two hundred yards, I turned to the right, followed by five of the men; and at the point where I had turned to the right, the seventh man turned to the left, followed by all the remainder. The two parties thus formed, after having

walked in opposite directions for a considerable distance, concealed themselves, and the bitch was put upon the common track of the whole party before the point of divergence. Following this common track with rapidity, she at first overshot the point of divergence; but, quickly recovering it, without any hesitation chose the track which turned to the right. Yet in this case my footprints in the common track were overlaid by eleven others, and in the track to the right by five others. Moreover, as it was the gamekeeper who brought up the rear, and as in the absence of my trail she would always follow his, the fact of his scent being, so to speak, upper most in the series was shown in no way to disconcert the animal when following another familiar scent lowermost in the series.

5. I requested the stranger before mentioned to wear my shooting boots, and in them to walk the park to leeward of the kennel. When the bitch was led to this trail, she followed it with the eagerness wherewith she always followed mine.

6. I wore this stranger's boots, and walked the park as he had done. On being taken to this trail, the bitch could not be induced to follow it.

7. The stranger walked the park in bare feet. The bitch would not follow the trail.

8. I walked the park in bare feet. The bitch followed my trail; but in quite a different manner from that which she displayed when following the trail of my shooting boots. She was so much less eager, and therefore so much less rapid, that her manner was suggestive of great uncertainty whether or not she was on my track.

9. I walked the park in new shooting boots, which had never been worn by any one. The bitch wholly refused to take this trail.

10. I walked the park in my old shooting boots, but having one layer of brown paper glued to their soles and sides. The bitch was led along my track, but paid no attention to it till she came to a place where, as I had previously observed, a small portion of the brown paper first became worn away at one of my heels. Here she immediately recognized my trail, and speedily followed it up, although the surface of shoe leather which touched the ground was not more than a few square millimeters.

11. I walked in my stocking soles, trying first with new cotton socks. The bitch lazily followed the trail a short distance and then gave it up. I next tried woolen socks which I had worn all day, but the result was the same, and therefore quite different from that yielded by my shooting boots, while more resembling that which was yielded by my bare feet.

12. I began to walk in my ordinary shooting boots, and when I had gone fifty yards, I kicked them off and carried them with me, while I continued to walk another three hundred yards in my stocking soles; then I took off my stockings, and walked another three hundred yards on my bare feet. On being taken to the beginning of this trail, or where I had started in my shooting boots, the bitch as usual set off upon it at full speed, nor did she abate this speed throughout the whole distance. In other words, having been once started upon the familiar scent of my shooting boots, she seemed to entertain no doubt that the scent of the stocking soles and of the bare feet belonged to me; although she did not clearly recognize them as belonging to me when they were not continuations of a track made by my shooting boots (10 and 11).

13. I requested a gentleman who was calling at the house, and whom the bitch had never before seen, to accompany me in a conveyance along one of the carriage drives. At a distance of several hundred yards from the house I alighted in my shooting boots, walked fifty yards beside the carriage, again entered it, while my friend alighted and walked two hundred yards still further along the drive. The bitch ran the whole 250 yards at her full speed, without making any pause at the place where the scent changed. This experiment was subsequently repeated with other strangers, and with the same result.

14. I walked in my ordinary shooting boots, having previously soaked them in oil of aniseed. Although the odor of the aniseed was so strong that an hour afterward the path which I had followed was correctly traced by a friend, this odor did not appear to disconcert the bitch in following my trail, for she ran me down as quickly as usual. It was noticed, however, by the friend who took her to the trail that she did not set off upon it as instantaneously as usual. She began by examining the first three or four footsteps with care, and only then started off at full speed.

15. Lastly, I tried some experiments on the power which this bitch might display of recognizing my individual odor as emanating from my whole person. In a large potato field behind the house, a number of laborers had been engaged for eight or ten hours in digging up and carrying away potatoes all the way along half a dozen adjacent "drills." Consequently, there was here a strip of bared land in the field about twenty yards wide, and a quarter of a mile long, which had been thoroughly well trampled over by many strange feet. Down this strip of land I walked in a zigzag course from end to end. On reaching the bottom I

turned out of the field, and again walked up a part of the way toward the house, but on the other side of a stone wall which bounded the field. This stone wall was breast high, and was situated nearly a hundred yards to windward of my previous course through the potatoes. The bitch, on being led out of the house, was put upon my trail at the top of the field, and at high speed picked out my trail among all the others, following roughly the various zigzags which I had taken. But the moment she gained the "wind's eye" of the place where I was standing behind the wall, she turned abruptly at a right angle, threw up her head, and came as straight as an arrow to the spot where I was watching her. Yet while watching her I had allowed only my eyes to come above the wall, so that she proved herself able to distinguish instantly the odor of the top of my head (without hat) at a distance of two hundred yards, although at the time she was surrounded by a number of overheated laborers.

16. On another day, when it was perfectly calm, I tried the experiment of standing in a deep dry ditch, with only the top of my uncovered head above the level of the surrounding fields. When she was led within two hundred yards of the place, she instantly perceived my odor, and ran in a straight line to where I had then ducked my head, so that she should receive no assistance from her sense of sight. This experiment shows that, in the absence of wind, the odor of my head (and no doubt, in a lesser degree, that of my body) had diffused itself through the air in all directions, and in an amount sufficient to enable the setter to recognize it as my odor at a distance of two hundred yards.

From the above experiments I conclude that this bitch distinguishes my trail from that of all others by the peculiar smell of my feet (8 to 11), and not by the peculiar smell of my boots (1 to 6), and that the smell which she recognizes as belonging distinctively to my trail is communicated to the boots by the exudations from my feet; but these exudations require to be combined with shoe leather before they are recognized by her. Probably, however, if I had always been accustomed to shoot without boots or stockings, she would have learnt to associate with me a trail made by my bare feet. The experiments further show that although a few square millimeters of the surface of one boot is amply sufficient to make a trail which the animal can recognize as mine, the scent is not able to penetrate a single layer of brown paper (10). Furthermore, it would appear that in following a trail this bitch is ready at any moment to be guided by inference as well as perception, but that the act of inference is instantaneous (12 and 13 as compared with 2, 8, and 11). Lastly, the experiments show that not only the feet (as these affect the boots) but likewise the whole body of a man exhales a peculiar or individual odor which a dog can recognize as that of his master amid a crowd of other persons (15); that the individual quality of this odor can be recognized at great distances to windward (15), or, in calm weather, at great distances in any direction (16); and that it does not admit of being overcome by the strong smell of aniseed (14) or by that of many other footprints (4).—*Nature*.

The Motive Force of the World.

The Bureau of Statistics in Berlin has recently issued some interesting information in connection with this subject. Four-fifths of the engines now working in the world have been constructed during the last 25 years. France owns 49,590 stationary or locomotive boilers, 7,000 locomotives, and 1,850 boats' boilers; Germany has 59,000 boilers, 10,000 locomotives, and 1,700 ships' boilers; Austria, 12,000 boilers and 2,800 locomotives. The force equivalent to the working steam engines represents: In the United States, 7,500,000 horse power; in England, 7,000,000 horse power; in Germany, 4,500,000; in France, 3,000,000; and in Austria, 1,500,000. In these figures the motive power of the locomotives is not included, whose number in all the world amounts to 105,000, representing a total of 3,000,000 horse power. Adding this amount to the other powers, we obtain the total of 46,000,000 horse power. A steam horse power is equal to three actual horses' power; and a living horse is equal to seven men. The steam engines of the world represent, therefore, approximately the work of 1,000,000,000 men, or more than double the working population of the earth, whose total population amounts to 1,455,923,000 inhabitants. Steam has accordingly trebled man's working power, enabling him to economize his physical strength while attending to his intellectual development.

Windmill Power for a Printing Office.

Mr. Max Nicolaus, editor of the *Avalanche*, Sauk Center, Minn., sends us photographs of his printing office, in which he has two job presses run by a windmill—a fact that is exciting considerable attention in that section. Wind is an important agent in the running of political newspapers, especially about election time, but its employment in such prosaic service as doing useful commercial printing is, we believe, quite exceptional.

* Paper read by Mr. George J. Romanes before the Linnean Society, on December 16, 1886. Reprinted from the Linnean Society's *Journal—Zoology*, vol. xx.

† "Mental Evolution in Animals," pp. 92, 93; where also see additional remarks of a general kind on the sense of smell in different animals.