the centre. The third screw is midway between the other two, and at the end of the plates.

Looking normally through the plates at the glowing filament of an incandescent lamp, a number of images of it will probably at first be seen. Adjust the pressure screws until these images are in juxtaposition in the line of sight; the silvered surfaces are then approximately parallel. Place the instrument in a clamp stand, and focus the light from a sodium flame or a vacuum tube upon the plates, and look at the interference bands with a small laboratory telescope focussed for infinity. Usually the eye-piece has too large a magnification for the above retardation, and it is better to use in place of it a single lens of focal length about 2 inches. At first only a small section of the interference pattern is seen, but with a little careful adjustment of the pressure screws the whole ring system is obtained in sharp focus. Removing the telescope, and with the above lens used as eye-piece, focus the interference system from the above sources, or an arc upon the slit of a spectroscope. The bands in the different spectrum lines are thus observed with the telescope on the spectrometer.

For further suggestions regarding the adjustments and other experiments for which this apparatus can be used reference may be made to an article by the writer in the *Philosophical Magazine* for May, 1904.

JAMES BARNES.

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An Ornithological Coincidence.

ON September 18, 1908, a fine, typical male of *Anthus bertheloti*, Bolle, the common Canary Islands pipit, was caught near Cremona, the first of its kind obtained in Italy. I received the interesting specimen "in the flesh." On March 16 of this year Mr. W. P. Pycraft presented at the meeting of the Zoological Society of London an account of the fossilised remains of a small Passerine bird from the "Gabbro" (Lower Pliocene) near Leghorn, which he identified as those of Berthelot's pipit (see NATURE, p. 119). The coincidence is certainly worth noting.

I may add that last autumn, during the later migrations, we had in Italy an unusual inflow of western species of birds, and amongst others and the above-mentioned pipit I received, also "in the flesh," a fine specimen of the large variety of the wheatear (*Saxicola leucorrhoa*, Gm.), known to breed in Greenland and to migrate southwards along the extreme west of Europe into Senegal. The specimen, a female, is the first registered in Italy; it was captured, also near Cremona, on November 7 last.

HENRY H. GIGLIOLI.

Royal Zoological Museum, Florence, March 29.

April Meteors.

MOONLIGHT will not hinder observations of the Lyrids and other shooting stars in the latter part of April in the present year. The following are the principal meteor showers that become due during the period April 19–30. The times of the various meteoric events as calculated by the writer are expressed in Greenwich mean time.

Epoch April 19, 12h. Shower of eighth order of magnitude, the maxima of which occur on April 20, 10h. 45m., 22h. 30m., and April 22, 6h. There is also another smaller shower connected with this having its maxima on April 20, 12h., April 21, 18h., and April 22, 7h.

Epoch April 25, 1h. This shower, which is of the thirteenth order of magnitude, has its principal maximum on April 27, 14h. Secondary maxima take place on April 25, 14h. 30m. and 20h. 30m.

Epoch April 29, 18h. Shower of seventh order of magnitude. Its principal maximum occurs on April 27, 9h. 45m., and there are other maxima on April 27, 23h. 45m., and April 29, 3h.

From the foregoing it seems that meteors should be found especially numerous on the nights of April 20 and 27. On the latter night there are two principal maxima occurring at times very suitable for observation.

April 12. JOHN R. HENRY.

THE GRAMOPHONE AS A PHONAUTOGRAPH.

IT is well known that during the last few years the gramophone (invented by Berliner in 1887), in its more complete and expensive forms, has been so much improved as to have completely eclipsed the phonograph. It is now an instrument that not only records pitch and intensity, but also quality to a surprising degree, so that one can listen to orchestral music in which the quality of each musical instrument is rendered with much fidelity, and also to the fine voices of many of the most celebrated vocalists of the day. Chorus effects are also remarkable, and one can, for example, enjoy the Soldiers' Chorus from *Faust* or the Wedding Chorus from *Lohengrin*. The nasal effects, the thin reediness of the voices, the alterations in quality, so characteristic of the phonograph, and of the gramophone in its earlier stages, have now almost entirely disappeared; indeed, it is no exaggeration to say that no scientific instruments have made greater progress since the inception of the phonograph a little more than thirty years ago.

Certain interesting data regarding the gramophone disk are worth recording. These I have determined on one of the smaller disks having a diameter of $10\frac{1}{2}$ inches, with the record beginning $\frac{1}{4}$ inch from the margin. The record then traces its spiral groove until it is $2\frac{1}{4}$ inches from the centre, so the record has a breadth of a little more than $2\frac{3}{4}$ inches, or, say, 3 inches. The diameter at the beginning of the record is 10 inches, in the middle 7 inches, and at the close of the spiral, towards the centre of the disk, 4 inches. Multiplying each by 3·14 gives the circumference of the circle as 31·4 inches, in the middle 21·98 inches, and in the centre 12·56 inches, or, together, 65·94 inches, giving a mean of 21·98 inches, or, say, 22 inches. There are 100 grooves per inch from the centre towards the circumference; $100 \times 22 = 2200$ inches; the breadth of the record $= 3$ inches; therefore $2200 \times 3 = 6600$ inches; or 550 feet, or 183 yards, is the average length of the record groove. That is to say, in reproducing Waldteufel's waltz, *Estudiantina*, the needle, in 205 seconds, ran over a distance of 550 feet. This gives a rate of 32·2 inches per second. With disks of a larger diameter, the length the groove in a long record may be more than 200 yards.

But when this record was reproduced (it is a remarkably good orchestral record) the disk travelled at the rate of 76 revolutions per minute, or 0·8 second per revolution. At the beginning of the record, therefore, 1 inch was covered in 3/100 second, at the middle in 4/100 second, and at the close of the record in 6/100 second. In other words, the needle traverses a shorter and shorter distance, but in the same time, in passing from the circumference to the centre. Consequently there is no alteration in pitch. It follows also that, given vibrations of the same frequency for a note sounding at the beginning of the record and at the close, the marks of each vibration must be closer together at the centre than at the circumference. Thus, supposing a frequency of 200 per second, there would be about six vibrations in an inch at the beginning (outer circumference) and twelve in an inch at the end of the record (centre). A note of 1000 vibrations per second would have thirty in an inch at the beginning, and sixty in an inch at the close of the record. I was able substantially to verify this by placing the disk under a microscope, with a low power, and counting the number of marks in a lineal inch. This also gives a convenient method of determining the pitch of any note, provided one can count a sufficient number of marks