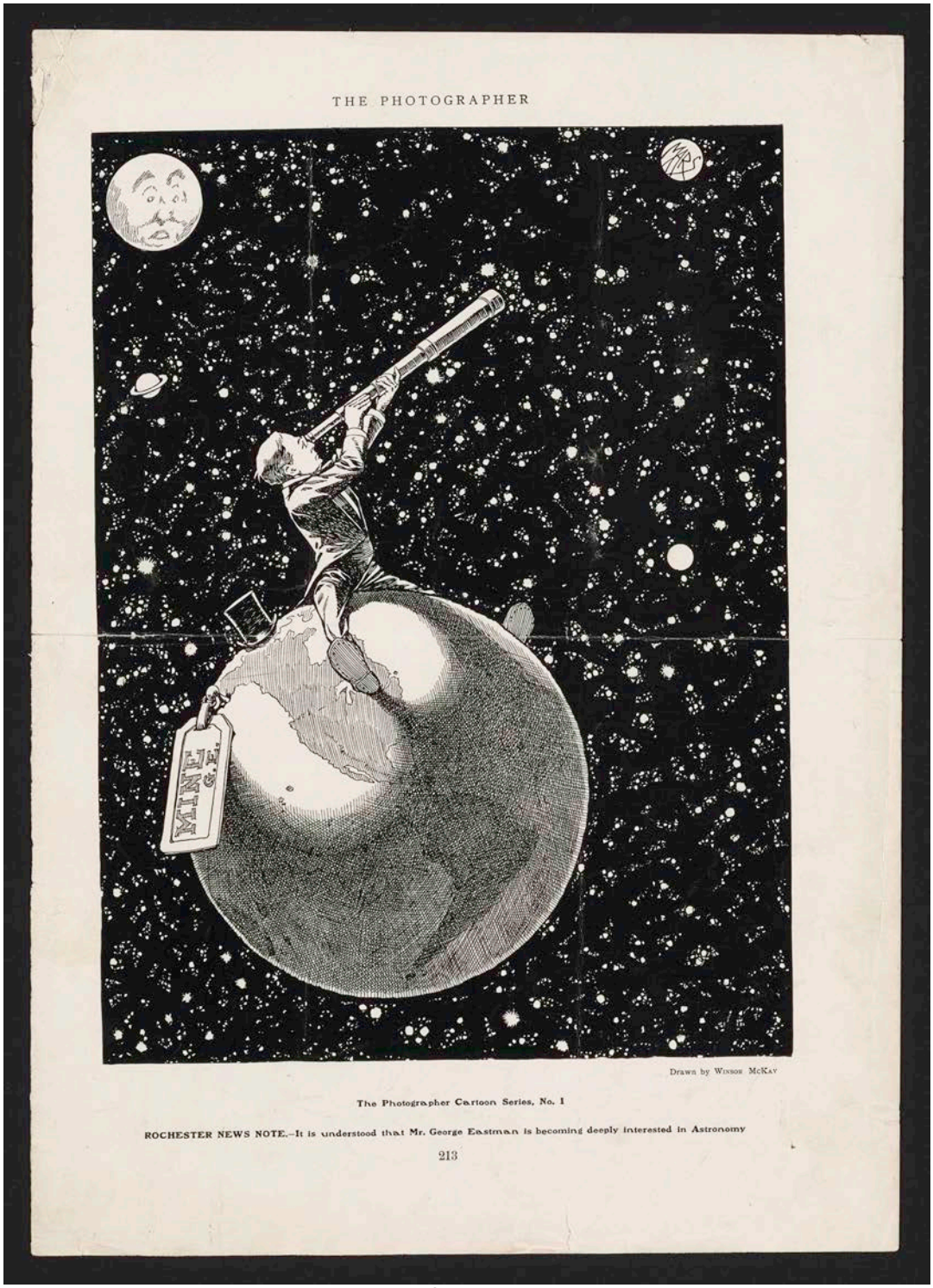

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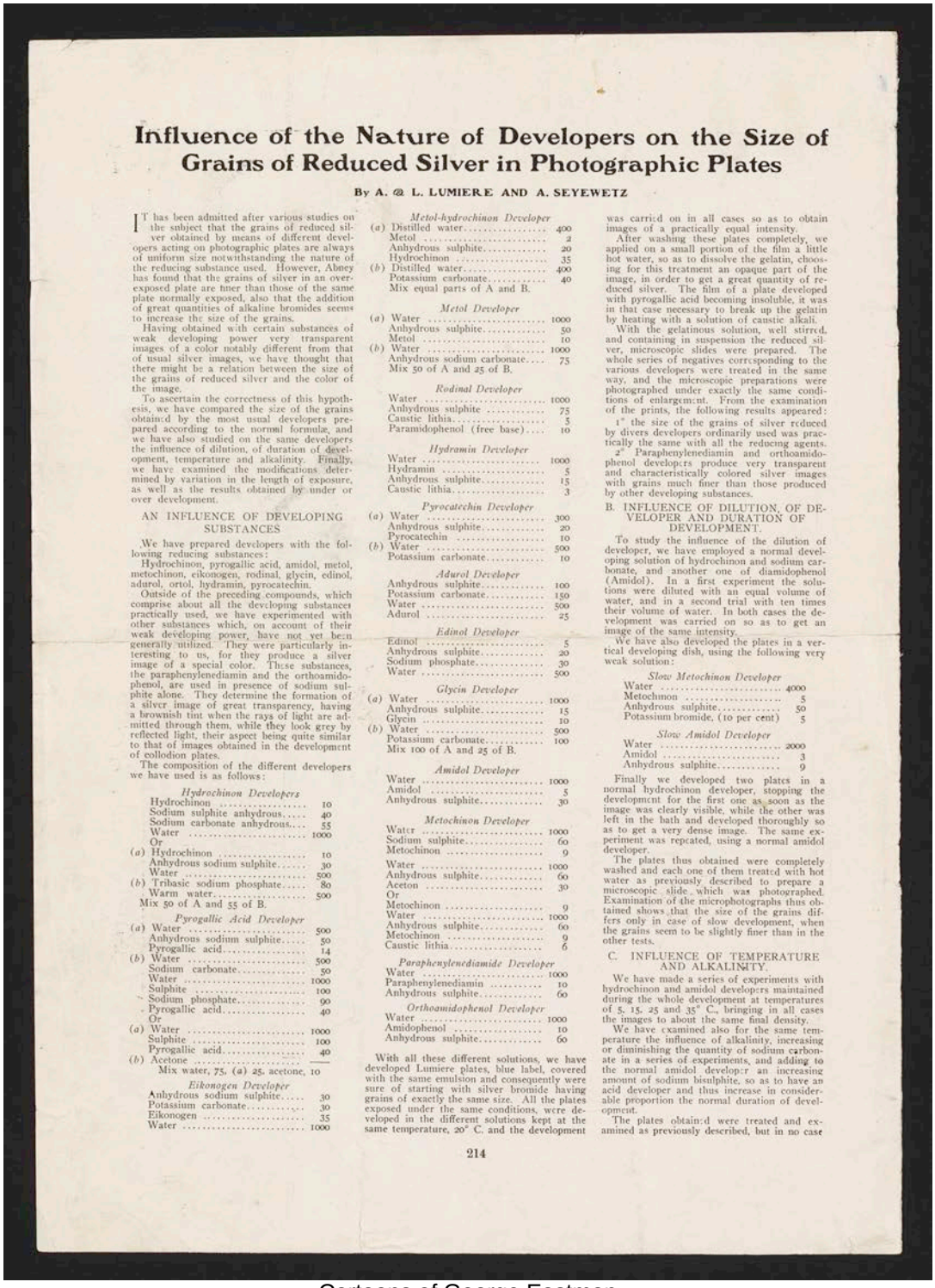

Influence of the Nature of Developers on the Size of Grains of Reduced Silver in Photographic Plates

By A. & L. LUMIERE AND A. SEYEWETZ

IT has been admitted after various studies on the subject that the grains of reduced silver obtained by means of different developers acting on photographic plates are always of uniform size notwithstanding the nature of the reducing substance used. However, Abney has found that the grains of silver in an over-exposed plate are finer than those of the same plate normally exposed, also that the addition of great quantities of alkaline bromides seems to increase the size of the grains.

Having obtained with certain substances of weak developing power very transparent images of a color notably different from that of usual silver images, we have thought that there might be a relation between the size of the grains of reduced silver and the color of the image.

To ascertain the correctness of this hypothesis, we have compared the size of the grains obtained by the most usual developers prepared according to the normal formulæ, and we have also studied on the same developers the influence of dilution, of duration of development, temperature and alkalinity. Finally, we have examined the modifications determined by variation in the length of exposure, as well as the results obtained by under or over development.

AN INFLUENCE OF DEVELOPING SUBSTANCES

We have prepared developers with the following reducing substances:

Hydrochinon, pyrogallic acid, amidol, metol, metochinon, eikonogen, rodinal, glycin, edinol, adurol, ortol, hydramin, pyrocatechin.

Outside of the preceding compounds, which comprise about all the developing substances practically used, we have experimented with other substances which, on account of their weak developing power, have not yet been generally utilized. They were particularly interesting to us, for they produce a silver image of a special color. These substances, the paraphenylenediamin and the orthoamidophenol, are used in presence of sodium sulphite alone. They determine the formation of a silver image of great transparency, having a brownish tint when the rays of light are admitted through them, while they look grey by reflected light, their aspect being quite similar to that of images obtained in the development of collodion plates.

The composition of the different developers we have used is as follows:

Hydrochinon Developers

Hydrochinon	10
Sodium sulphite anhydrous	40
Sodium carbonate anhydrous	55
Water	1000
Or	
(*a*) Hydrochinon	10
Anhydrous sodium sulphite	30
Water	500
(*b*) Tribasic sodium phosphate	80
Warm water	500

Mix 50 of A and 55 of B.

Pyrogallic Acid Developer

(*a*) Water	500
Anhydrous sodium sulphite	50
Pyrogallic acid	14
(*b*) Water	500
Sodium carbonate	50
Water	1000
Sulphite	100
Sodium phosphate	90
Pyrogallic acid	40
Or	
(*a*) Water	1000
Sulphite	100
Pyrogallic acid	40
(*b*) Acetone	—

Mix water, 75, (*a*) 25, acetone, 10

Eikonogen Developer

Anhydrous sodium sulphite	30
Potassium carbonate	30
Eikonogen	35
Water	1000

Metol-hydrochinon Developer

(*a*) Distilled water	400
Metol	2
Anhydrous sulphite	20
Hydrochinon	35
(*b*) Distilled water	400
Potassium carbonate	40

Mix equal parts of A and B.

Metol Developer

(*a*) Water	1000
Anhydrous sulphite	50
Metol	10
(*b*) Water	1000
Anhydrous sodium carbonate	75

Mix 50 of A and 25 of B.

Rodinal Developer

Water	1000
Anhydrous sulphite	75
Caustic lithia	5
Paramidophenol (free base)	10

Hydramin Developer

Water	1000
Hydramin	5
Anhydrous sulphite	15
Caustic lithia	3

Pyrocatechin Developer

(*a*) Water	300
Anhydrous sulphite	20
Pyrocatechin	10
(*b*) Water	500
Potassium carbonate	10

Adurol Developer

Anhydrous sulphite	100
Potassium carbonate	150
Water	500
Adurol	25

Edinol Developer

Edinol	5
Anhydrous sulphite	20
Sodium phosphate	30
Water	500

Glycin Developer

(*a*) Water	1000
Anhydrous sulphite	15
Glycin	10
(*b*) Water	500
Potassium carbonate	100

Mix 100 of A and 25 of B.

Amidol Developer

Water	1000
Amidol	5
Anhydrous sulphite	30

Metochinon Developer

Water	1000
Sodium sulphite	60
Metochinon	9
Water	1000
Anhydrous sulphite	60
Aceton	30
Or	
Metochinon	9
Water	1000
Anhydrous sulphite	60
Metochinon	9
Caustic lithia	6

Paraphenylenediamide Developer

Water	1000
Paraphenylenediamin	10
Anhydrous sulphite	60

Orthoamidophenol Developer

Water	1000
Amidophenol	10
Anhydrous sulphite	60

With all these different solutions, we have developed Lumiere plates, blue label, covered with the same emulsion and consequently were sure of starting with silver bromide having grains of exactly the same size. All the plates exposed under the same conditions, were developed in the different solutions kept at the same temperature, 20° C. and the development was carried on in all cases so as to obtain images of a practically equal intensity.

After washing these plates completely, we applied on a small portion of the film a little hot water, so as to dissolve the gelatin, choosing for this treatment an opaque part of the image, in order to get a great quantity of reduced silver. The film of a plate developed with pyrogallic acid becoming insoluble, it was in that case necessary to break up the gelatin by heating with a solution of caustic alkali.

With the gelatinous solution, well stirred, and containing in suspension the reduced silver, microscopic slides were prepared. The whole series of negatives corresponding to the various developers were treated in the same way, and the microscopic preparations were photographed under exactly the same conditions of enlargement. From the examination of the prints, the following results appeared:

1° the size of the grains of silver reduced by divers developers ordinarily used was practically the same with all the reducing agents.

2° Paraphenylenediamin and orthoamidophenol developers produce very transparent and characteristically colored silver images with grains much finer than those produced by other developing substances.

B. INFLUENCE OF DILUTION, OF DEVELOPER AND DURATION OF DEVELOPMENT.

To study the influence of the dilution of developer, we have employed a normal developing solution of hydrochinon and sodium carbonate, and another one of diamidophenol (Amidol). In a first experiment the solutions were diluted with an equal volume of water, and in a second trial with ten times their volume of water. In both cases the development was carried on so as to get an image of the same intensity.

We have also developed the plates in a vertical developing dish, using the following very weak solution:

Slow Metochinon Developer

Water	4000
Metochinon	5
Anhydrous sulphite	50
Potassium bromide, (10 per cent)	5

Slow Amidol Developer

Water	2000
Amidol	3
Anhydrous sulphite	9

Finally we developed two plates in a normal hydrochinon developer, stopping the development for the first one as soon as the image was clearly visible, while the other was left in the bath and developed thoroughly so as to get a very dense image. The same experiment was repeated, using a normal amidol developer.

The plates thus obtained were completely washed and each one of them treated with hot water as previously described to prepare a microscopic slide which was photographed. Examination of the microphotographs thus obtained shows that the size of the grains differs only in case of slow development, when the grains seem to be slightly finer than in the other tests.

C. INFLUENCE OF TEMPERATURE AND ALKALINITY.

We have made a series of experiments with hydrochinon and amidol developers maintained during the whole development at temperatures of 5, 15, 25 and 35° C., bringing in all cases the images to about the same final density.

We have examined also for the same temperature the influence of alkalinity, increasing or diminishing the quantity of sodium carbonate in a series of experiments, and adding to the normal amidol developer an increasing amount of sodium bisulphite, so as to have an acid developer and thus increase in considerable proportion the normal duration of development.

The plates obtained were treated and examined as previously described, but in no case

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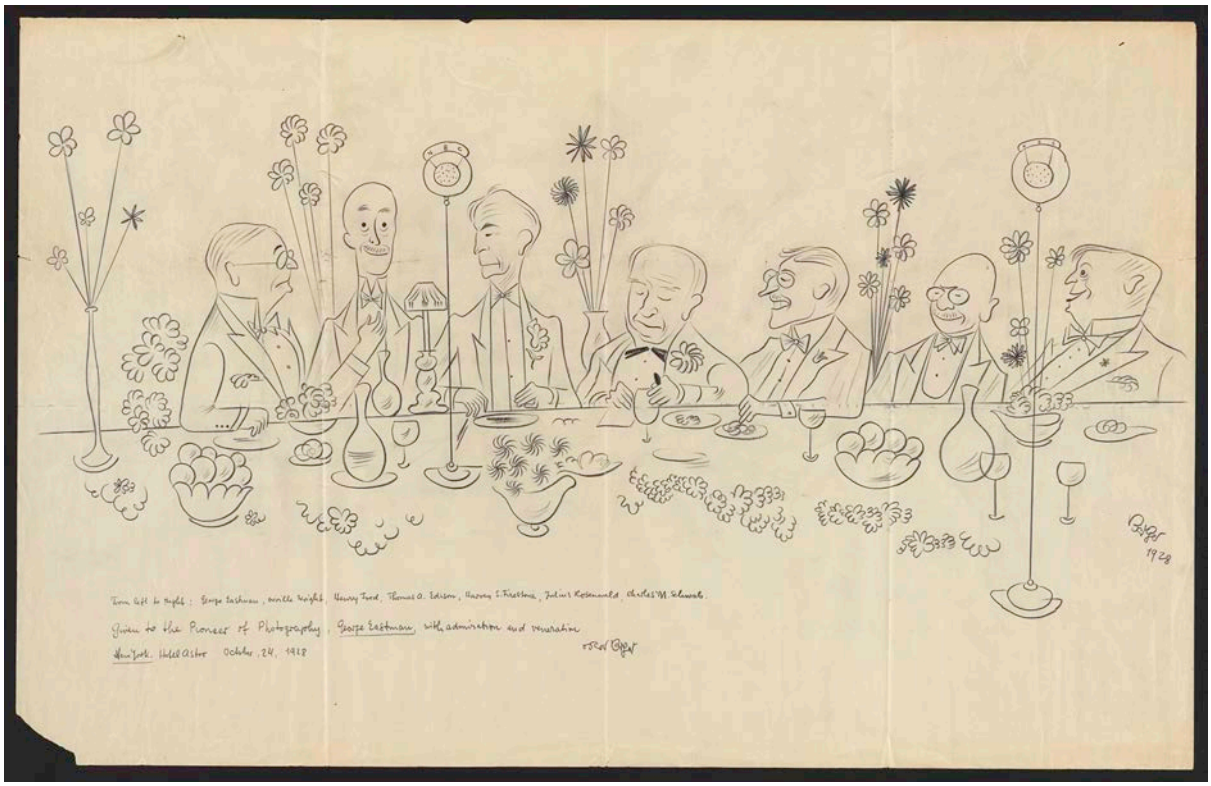

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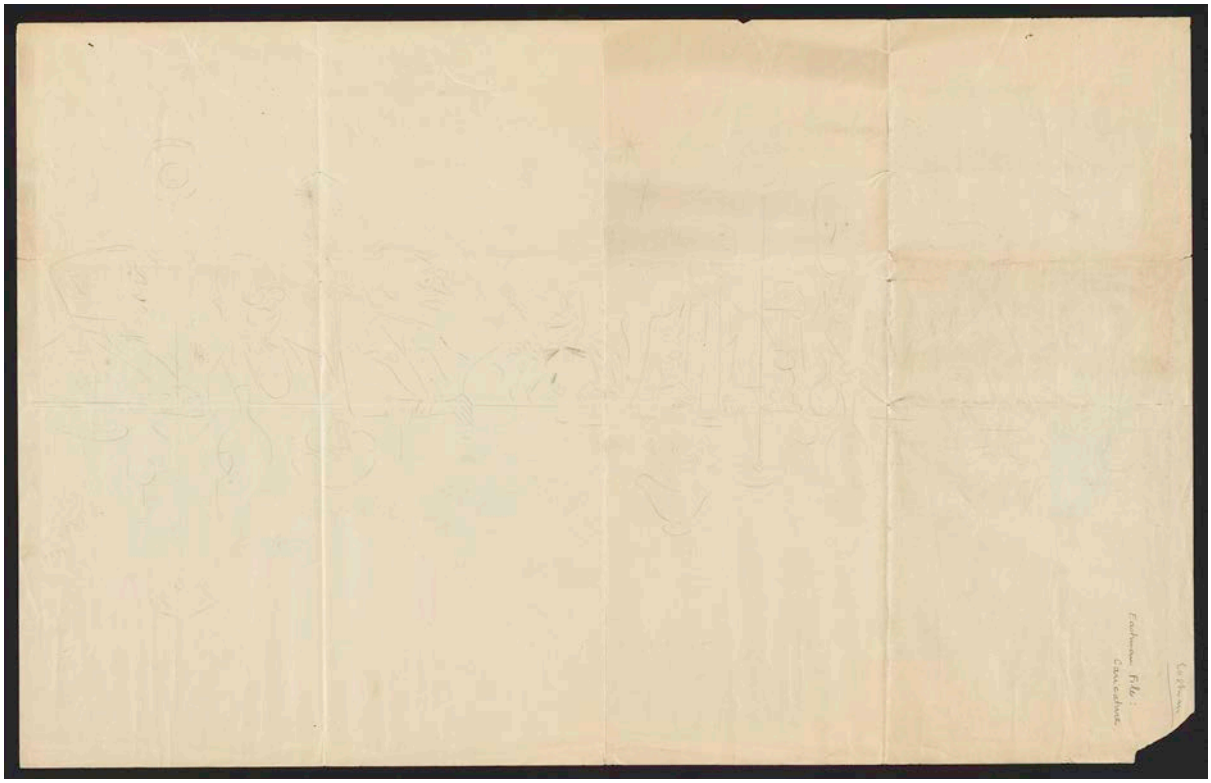

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