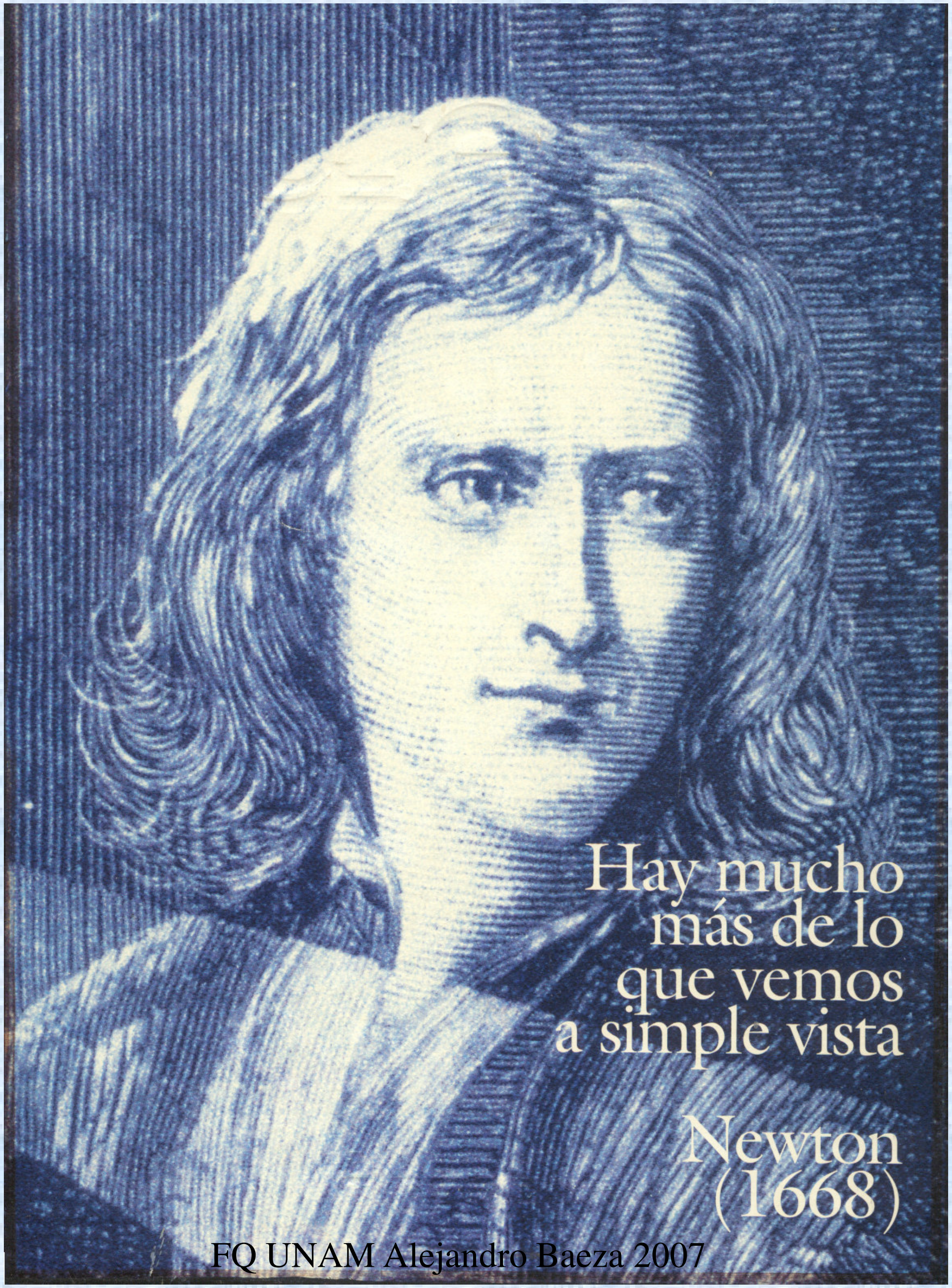
química analítica instrumental (I)

Métodos de Alta Energía

*Emisión de Flama
*Absorción Atómica
**ICP*

Facultad de Química UNAM *Dr. Alejandro Baeza*

El principio


Hay mucho
más de lo
que vemos
a simple vista
Newton
(1668)

The Foundations of Newton's Alchemy

or

"The Hunting of the Greene Lyon"

BETTY JO TEETER DOBBS

Assistant Professor of History
Northwestern University, Evanston, Illinois

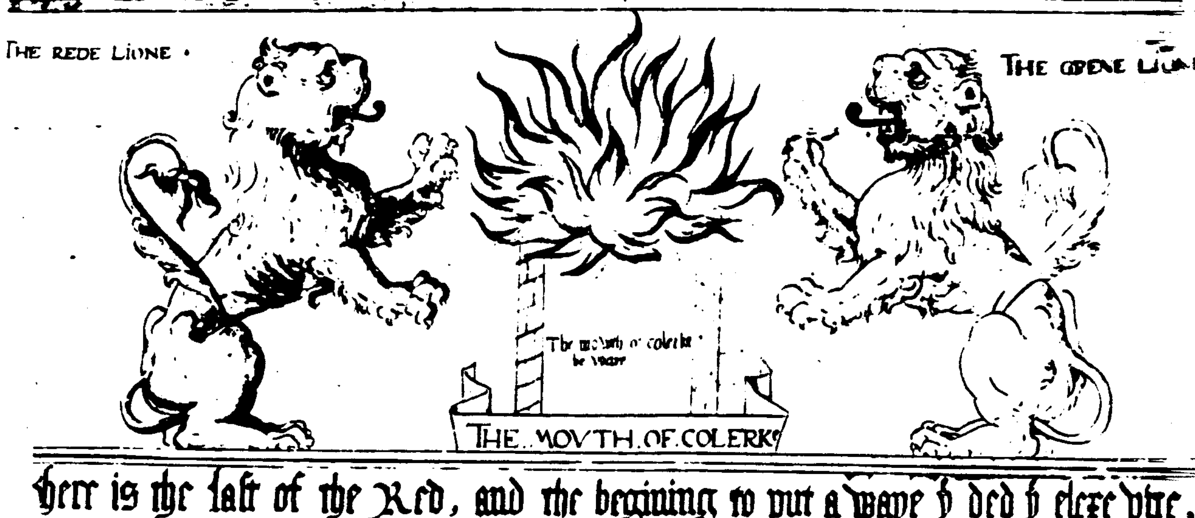


Plate I. RED AND GREEN "LYONS" FROM A RIPLEY "SCROWLE".

According to the Jungian analysis of the older alchemy, this pair of lions is a symbolic representation of paired psychic functions. (Reproduced by permission of the Syndics of the Fitzwilliam Museum, Cambridge.)

Cambridge University Press

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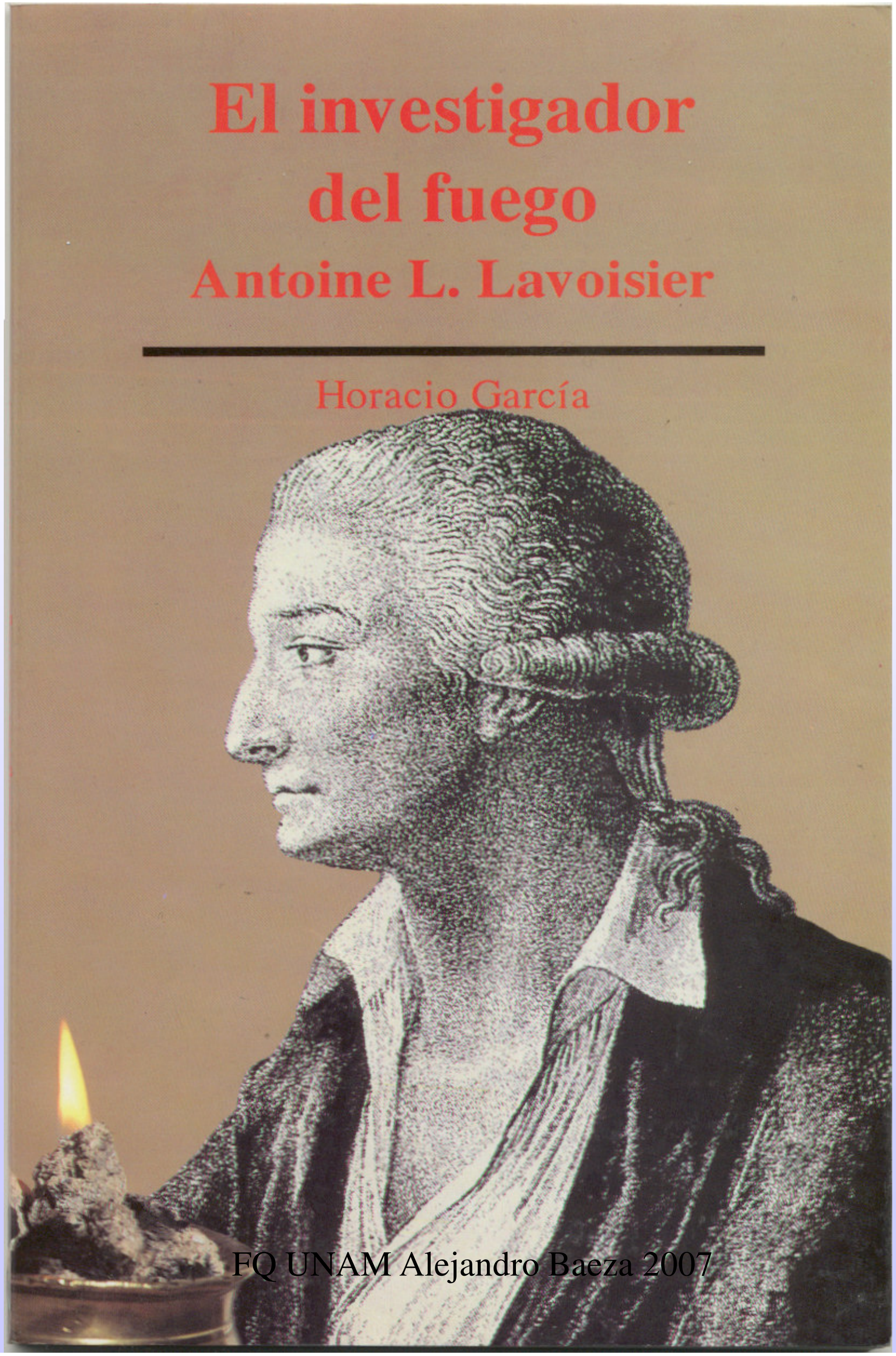
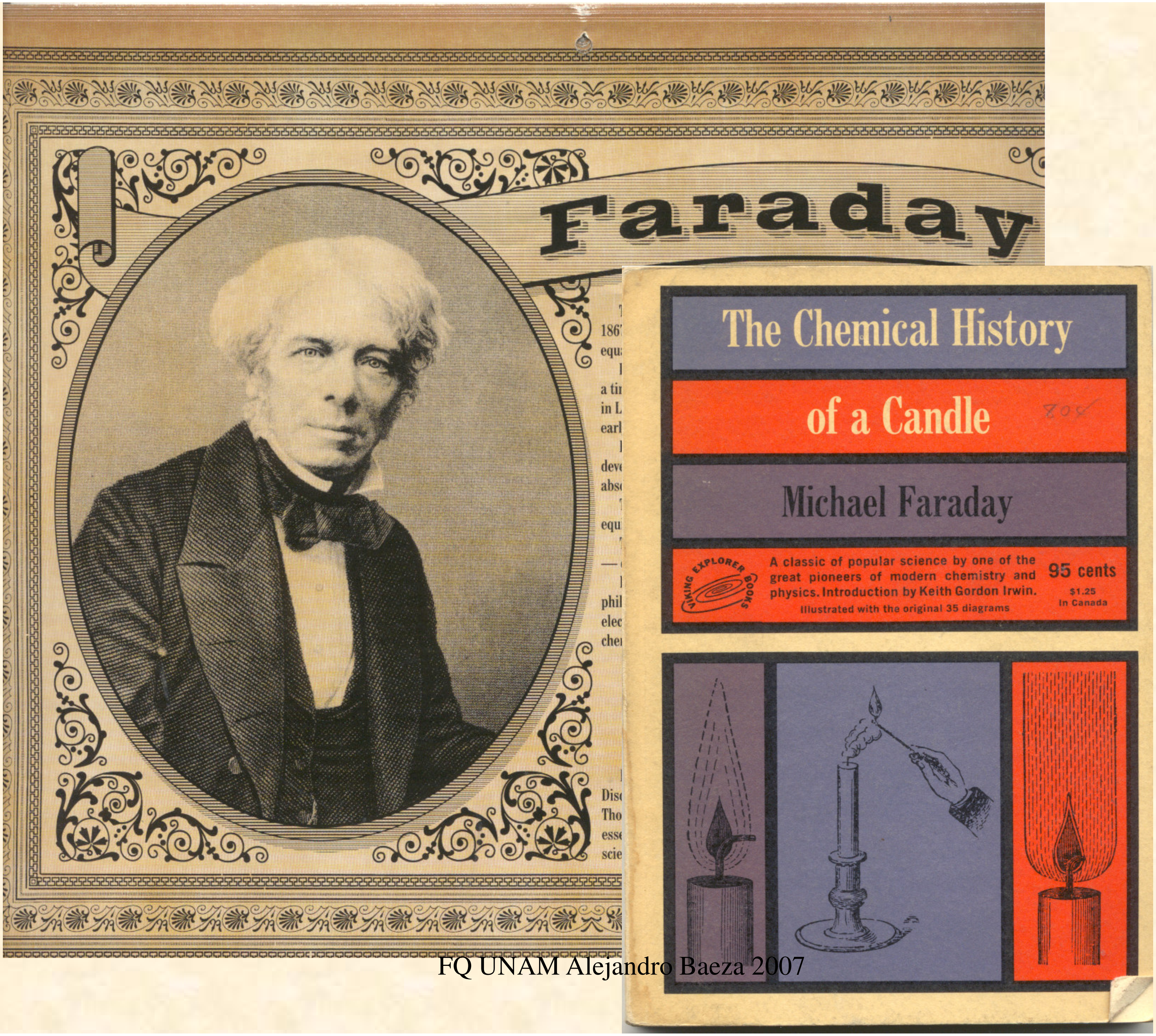

El investigador
del fuego
Antoine L. Lavoisier
Horacio García


Faraday
The Chemical History
of a Candle
Michael Faraday
VIKING EXPLORER BOOKS
A classic of popular science by one of the great pioneers of modern chemistry and physics. Introduction by Keith Gordon Irwin.
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$1.25
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being changed. Before we have concluded this course of lectures, we shall shew you a lamp in which the flame goes up and the smoke goes down, or the flame goes down and the smoke goes up. You see, then, that we have the power in this way of varying the flame in different directions.

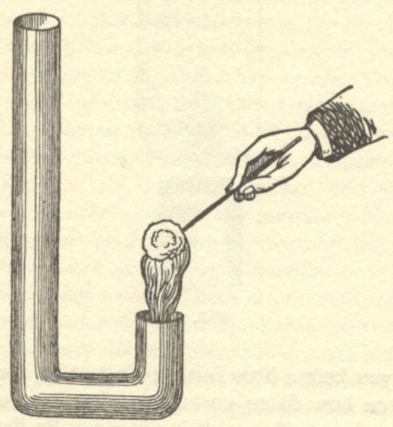


FIG. 5.

There are now some other points that I must bring before you. Many of the flames you see here vary very much in their shape by the currents of air blowing around them in different directions; but we can, if we like, make flames so that they will look like fixtures, and we can photograph them—indeed, we have to photograph them, so that they become fixed to us, if we wish to find out everything concerning them. That, however, is not the only thing I wish to mention. If I take a flame sufficiently large, it does not keep that homogeneous, that uniform condition of shape, but it breaks out with a power of life which is quite wonderful. I am about to use another kind of fuel, but one which is truly and fairly a representative of the wax or tallow of a candle. I have here a large ball of cotton, which will serve as a

wick. And, now that I have immersed it in spirit and app
light to it, in what way does it differ from an ordinary ca
Why, it differs very much in one respect, that we have a vi
and power about it, a beauty and a life entirely different
the light presented by a candle. You see those fine tong
flame rising up. You have the same general disposition
mass of the flame from below upwards; but, in addition to
you have this remarkable breaking out into tongues which y
not perceive in the case of a candle. Now, why is this? I
explain it to you, because when you understand that per
you will be able to follow me better in what I have to say
after. I suppose some here will have made for themselve
experiment I am going to shew you. Am I right in supp
that anybody here has played at snapdragon? I do not kn
more beautiful illustration of the philosophy of flame, as
certain part of its history, than the game of snapdragon.
here is the dish; and let me say, that when you play snapd
properly, you ought to have the dish well-warmed; you
also to have warm plums and warm brandy, which, howe
have not got. When you have put the spirit into the dish
have the cup and the fuel; and are not the raisins acting
the wicks? I now throw the plums into the dish, and ligh
spirit, and you see those beautiful tongues of flame that I
to. You have the air creeping in over the edge of the dish
ing these tongues. Why? Because, through the force of the
rent and the irregularity of the action of the flame, it cannot
in one uniform stream. The air flows in so irregularly tha
have what would otherwise be a single image, broken up i
variety of forms, and each of these little tongues has an
pendent existence of its own. Indeed, I might say, you have
a multitude of independent candles. You must not imagine
cause you see these tongues all at once, that the flame is o
particular shape. A flame of that shape is never so at any
time. Never is a body of flame, like that which you just
rising from the ball, of the shape it appears to you. It consi
a multitude of different shapes, succeeding each other so
that the eye is only able to take cognisance of them all at

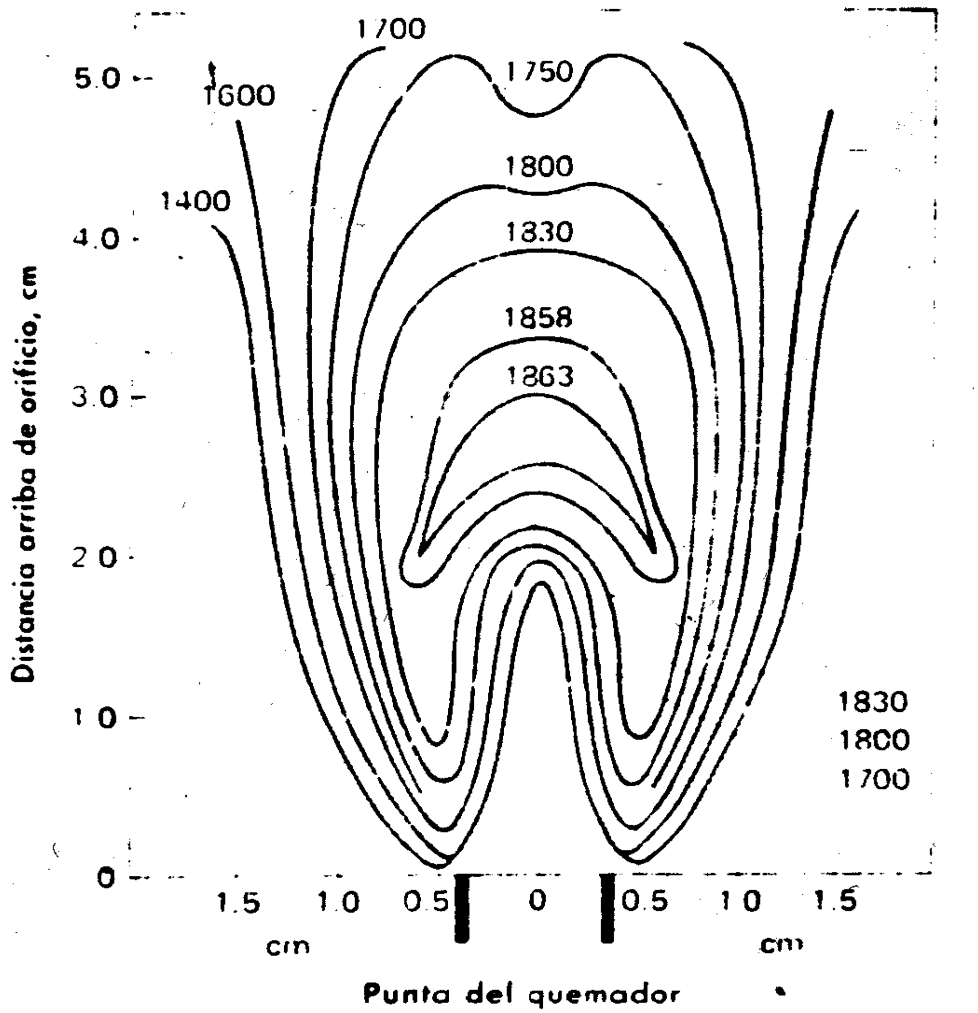
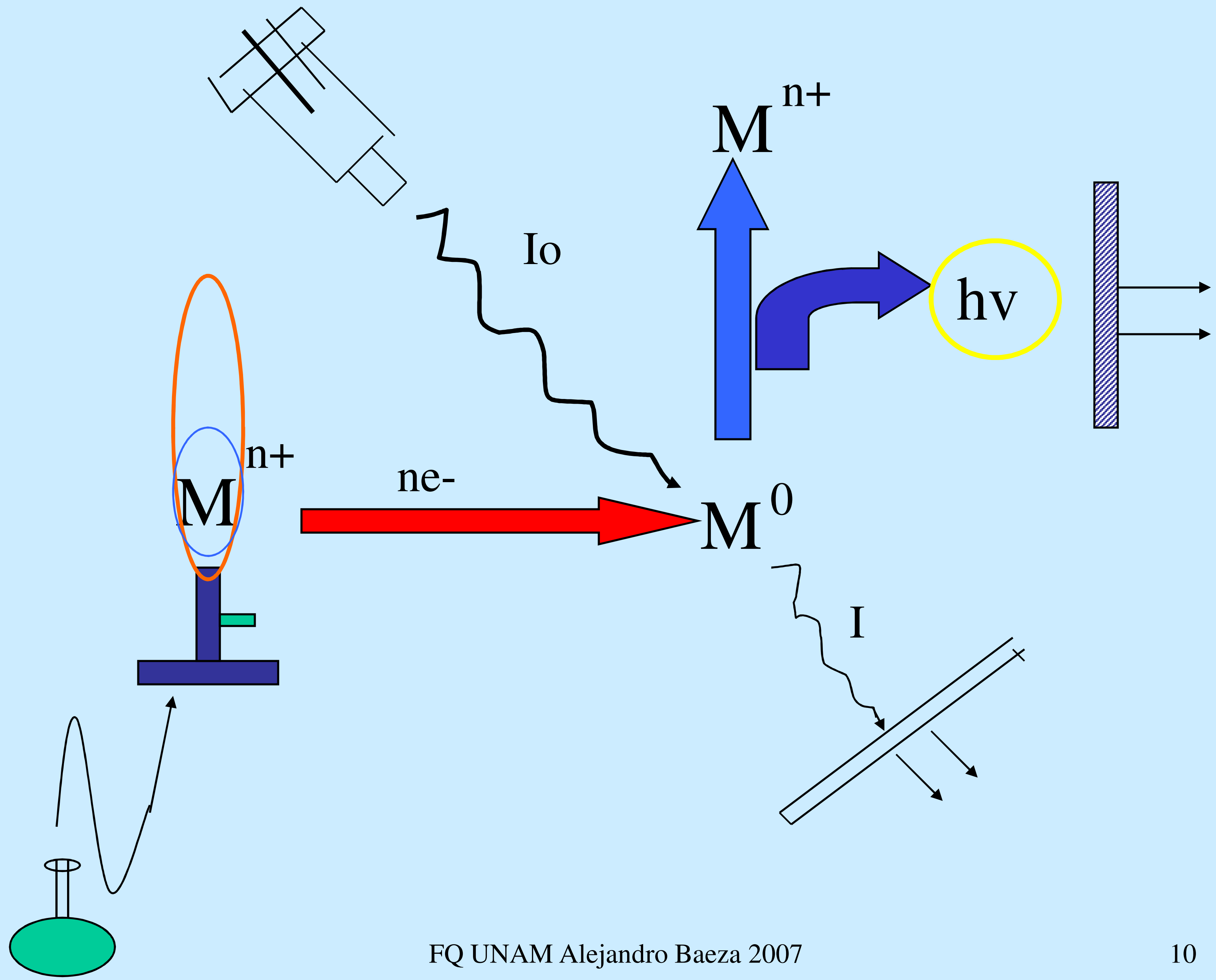


Fig. 11-6. Perfiles de temperaturas (en grados C) para una llama de gas natural y aire. De B. Lewis y G. van Elbe, *J. Chem, Phys.*, **11**, 75 (1943). (Con autorización.)

Tabla 11-2. Temperaturas máximas de llama con varios combustibles oxidantes[a]

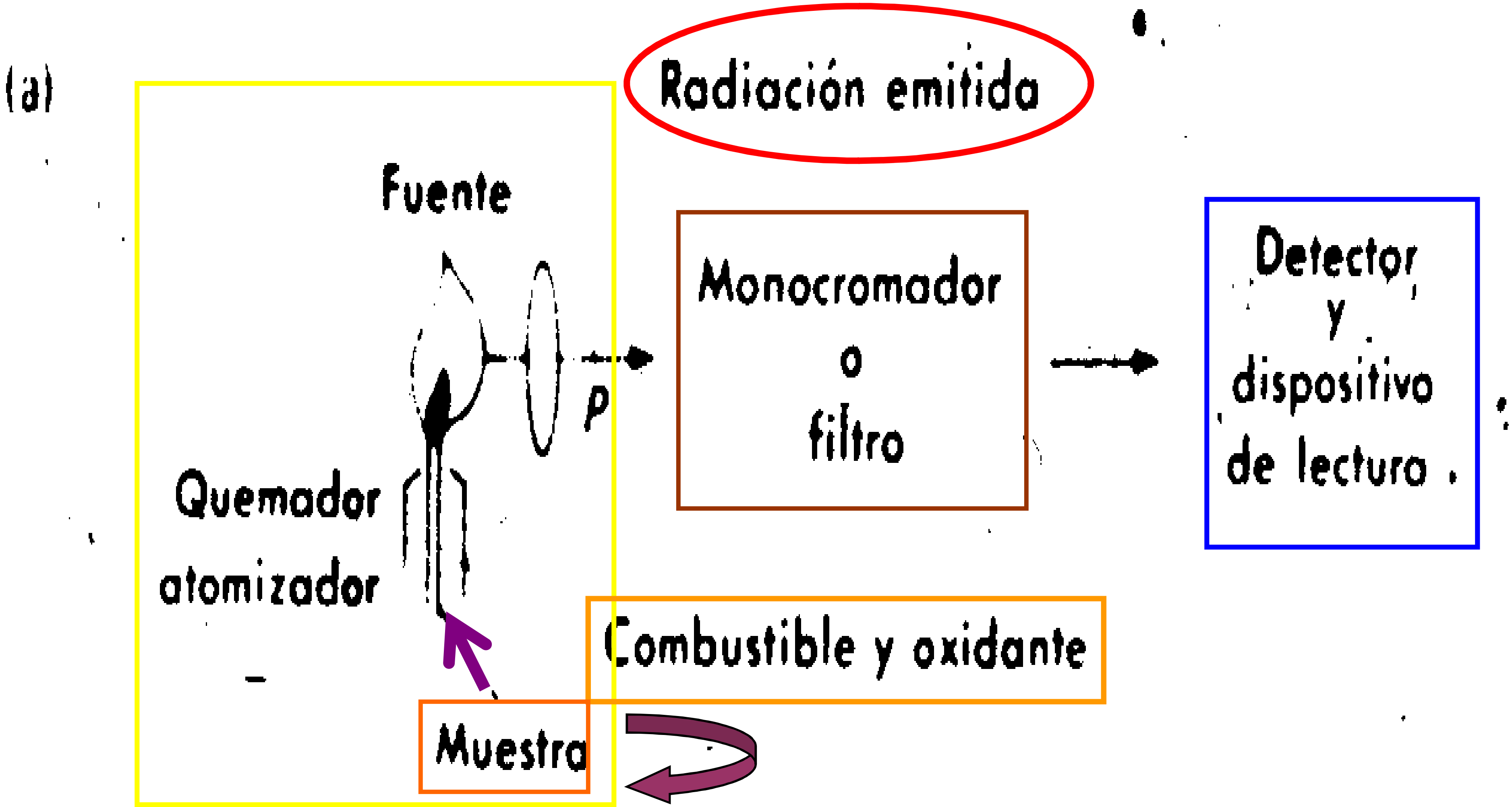
Combustible	*Oxidante*	*Temperaturas medias, °C*
Gas natural	Aire	1 700-1 900
Gas natural	Oxígeno	2 740
Hidrógeno	Aire	2 000-2 050
Hidrógeno	Oxígeno	2 550-2 700
Acetileno	Aire	2 125-2 400
Acetileno	Oxígeno	3 060-3 135
Acetileno	Oxido nitroso	2 600-2 800
Cianógeno	Oxígeno	4 500

[a]Datos tomados de R.N. Kniseley en *Flame Emission and Atomic Absorption Spectroscopy* eds. J.A. Dean y T.C. Rains. London: Marcel Dekker, vol. 1, p. 191. Con autorización.

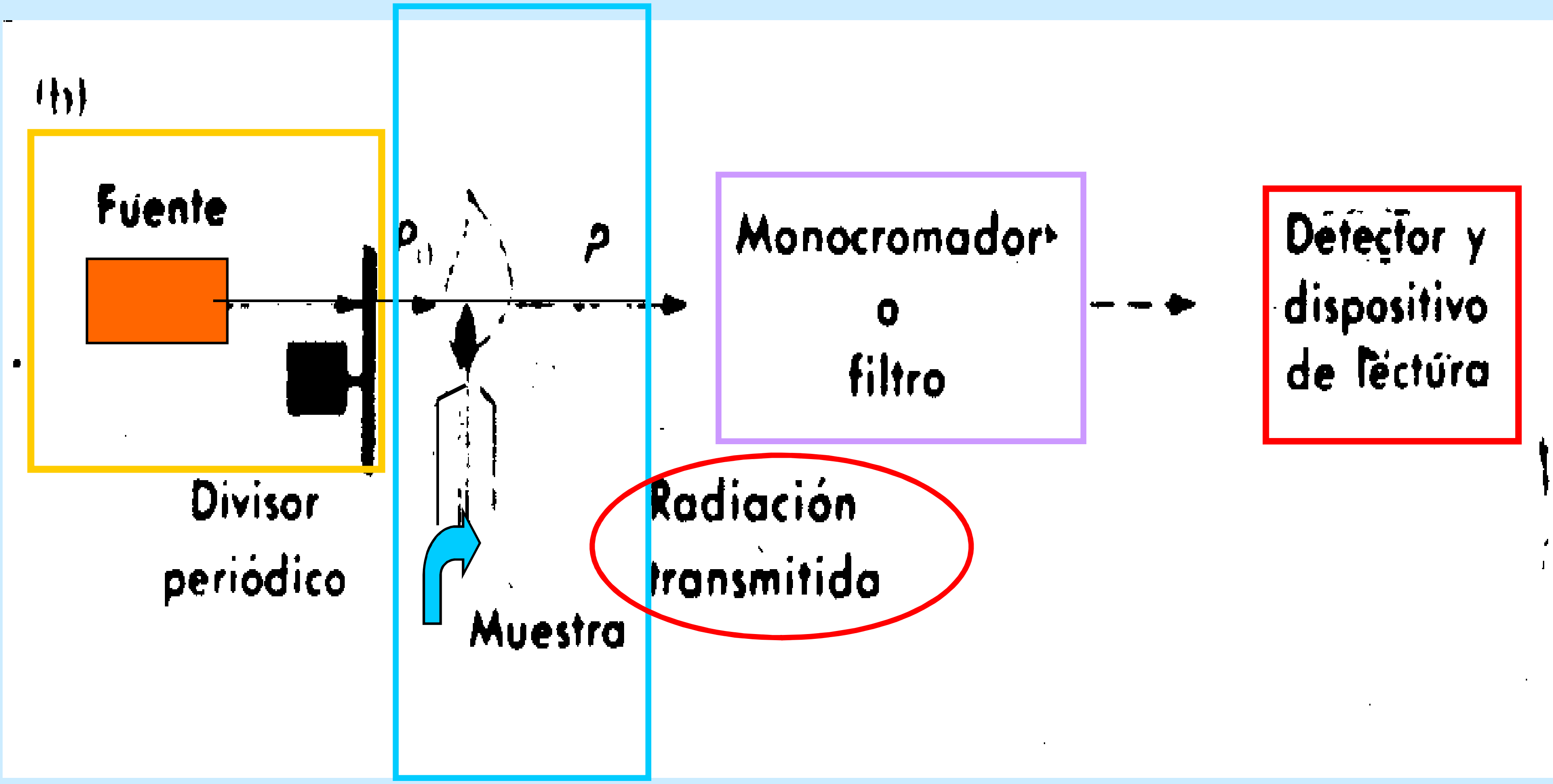


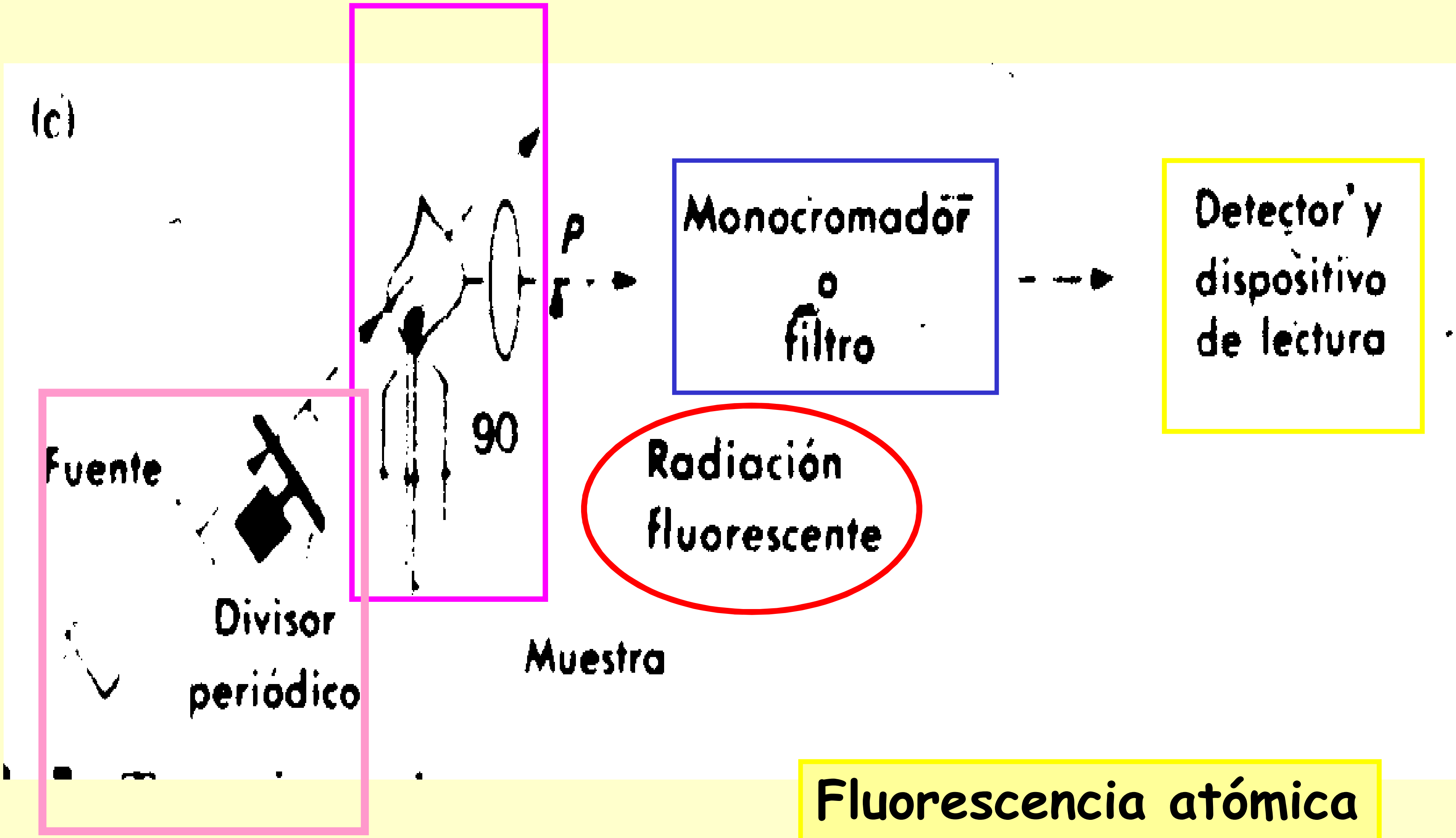
M n+
Io
hv
M n+
ne-
M 0
I

Emisión de flama (flamometría)



Absorción Atómica (AAE)





Fluorescencia atómica

[3] Para un estudio detallado sobre los atomizadores de llama, véase: R.D. Dresser, R.A. Mooney, E.M. Heithmar, y F.W. Pankey, *J. Chem. Educ.* 52, A403 (1975).

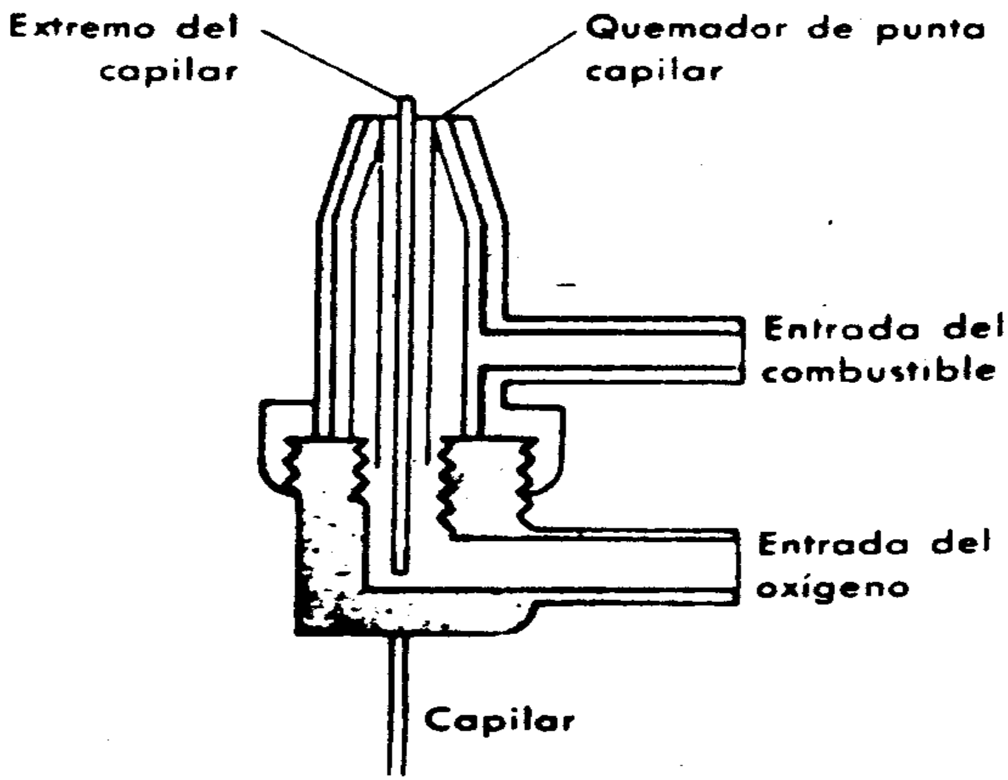


Fig. 11-9. Un quemador de flujo turbulento. (Cortesía de Beckman Instrument Inc., Fullerton, California).

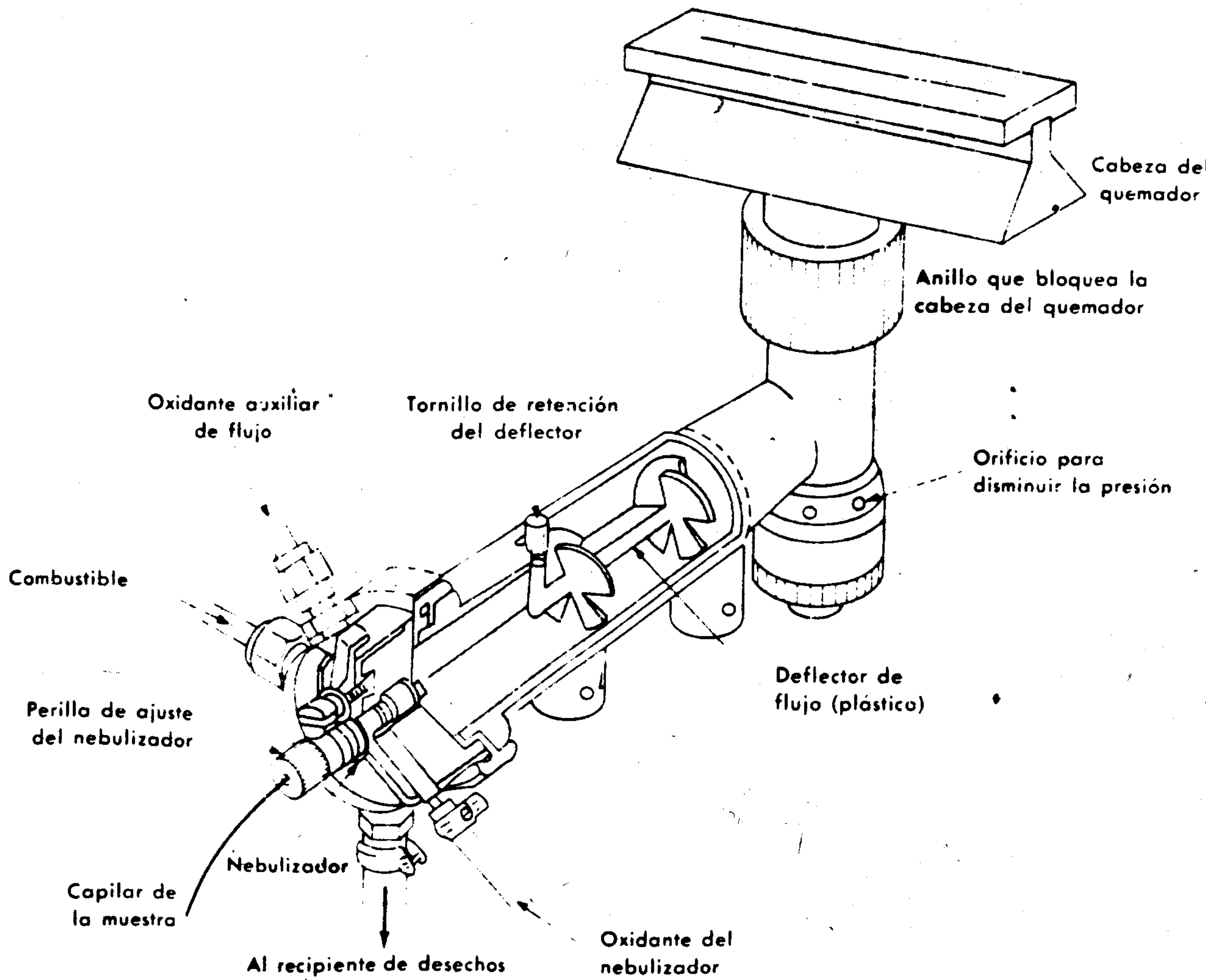
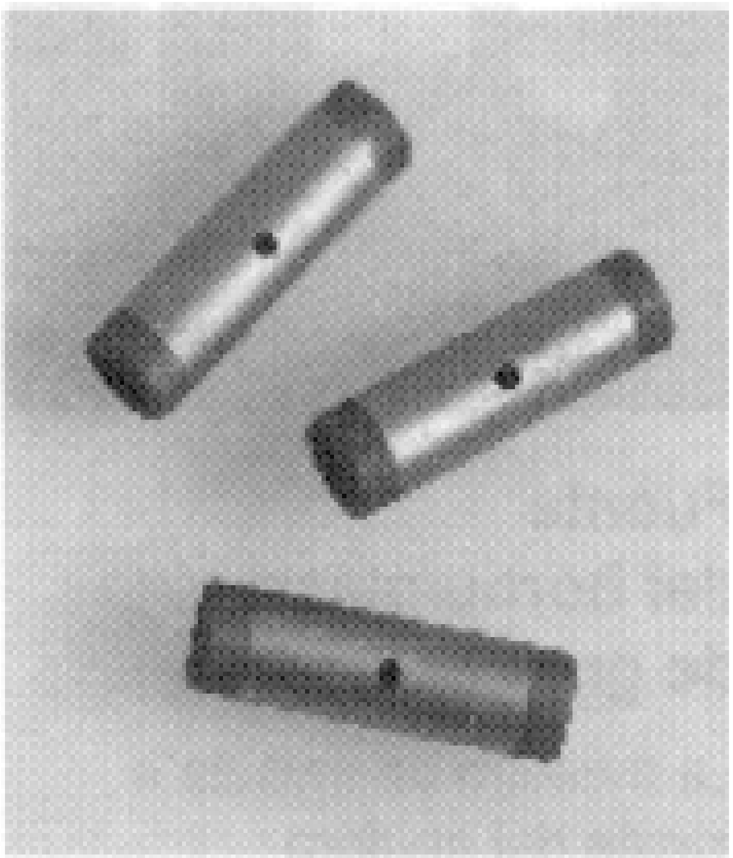
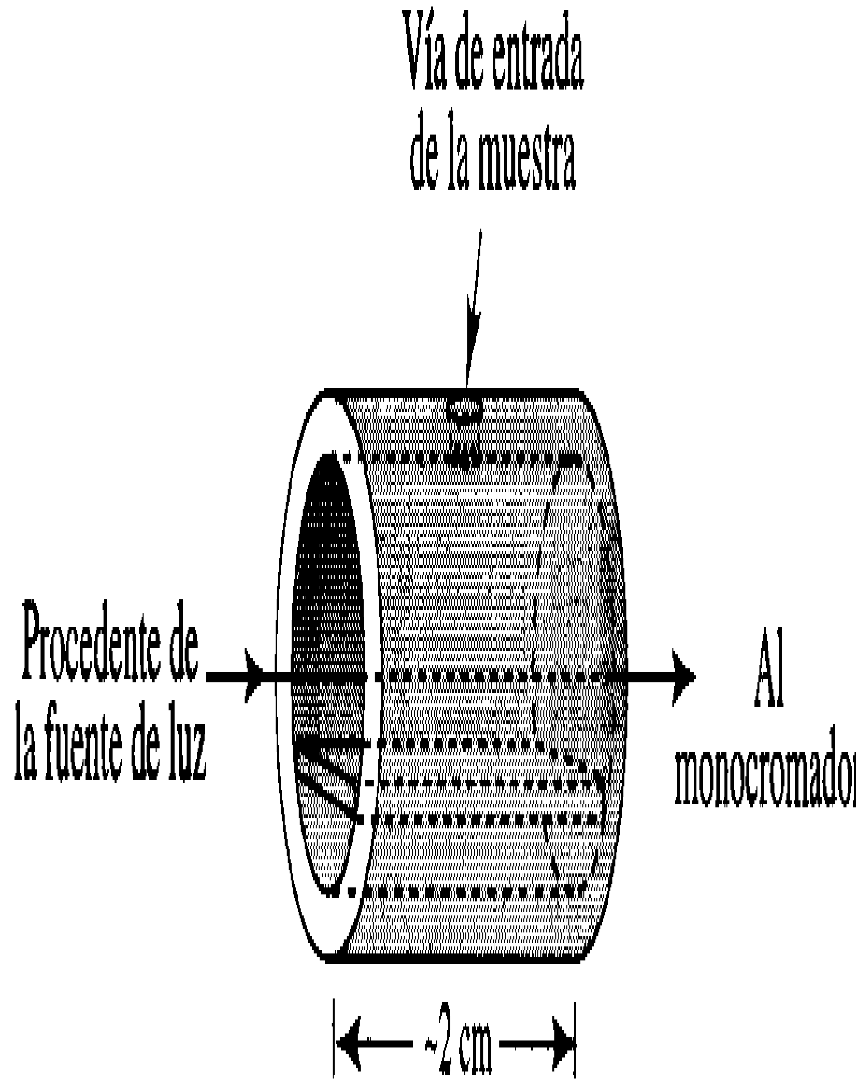


Fig. 11-10. Un quemador de flujo laminar. (Cortesía de Perkin-Elmer Corporation. Norwalk, Connecticut.)



Tubos de grafito empleados en espectrometría atómica.



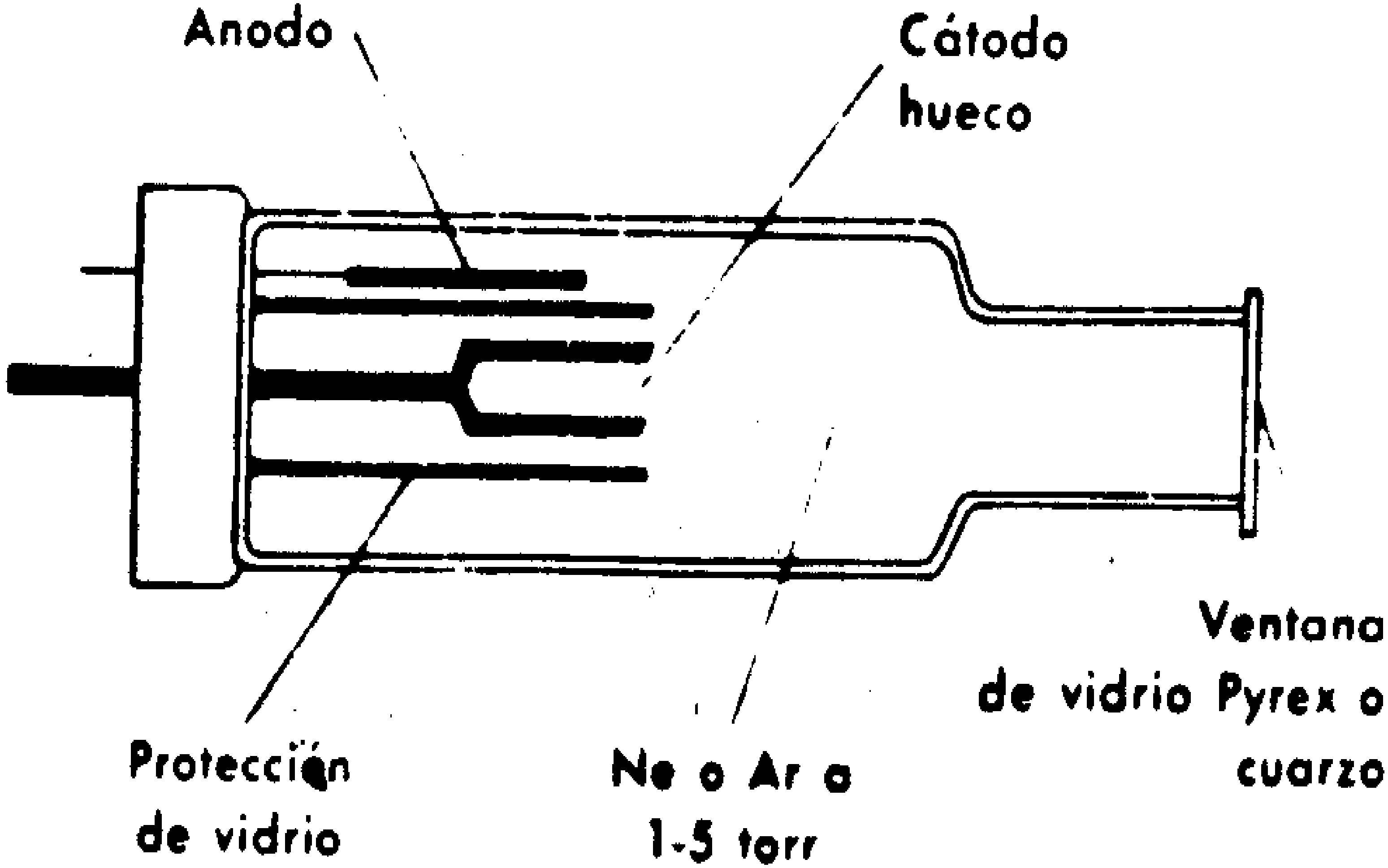
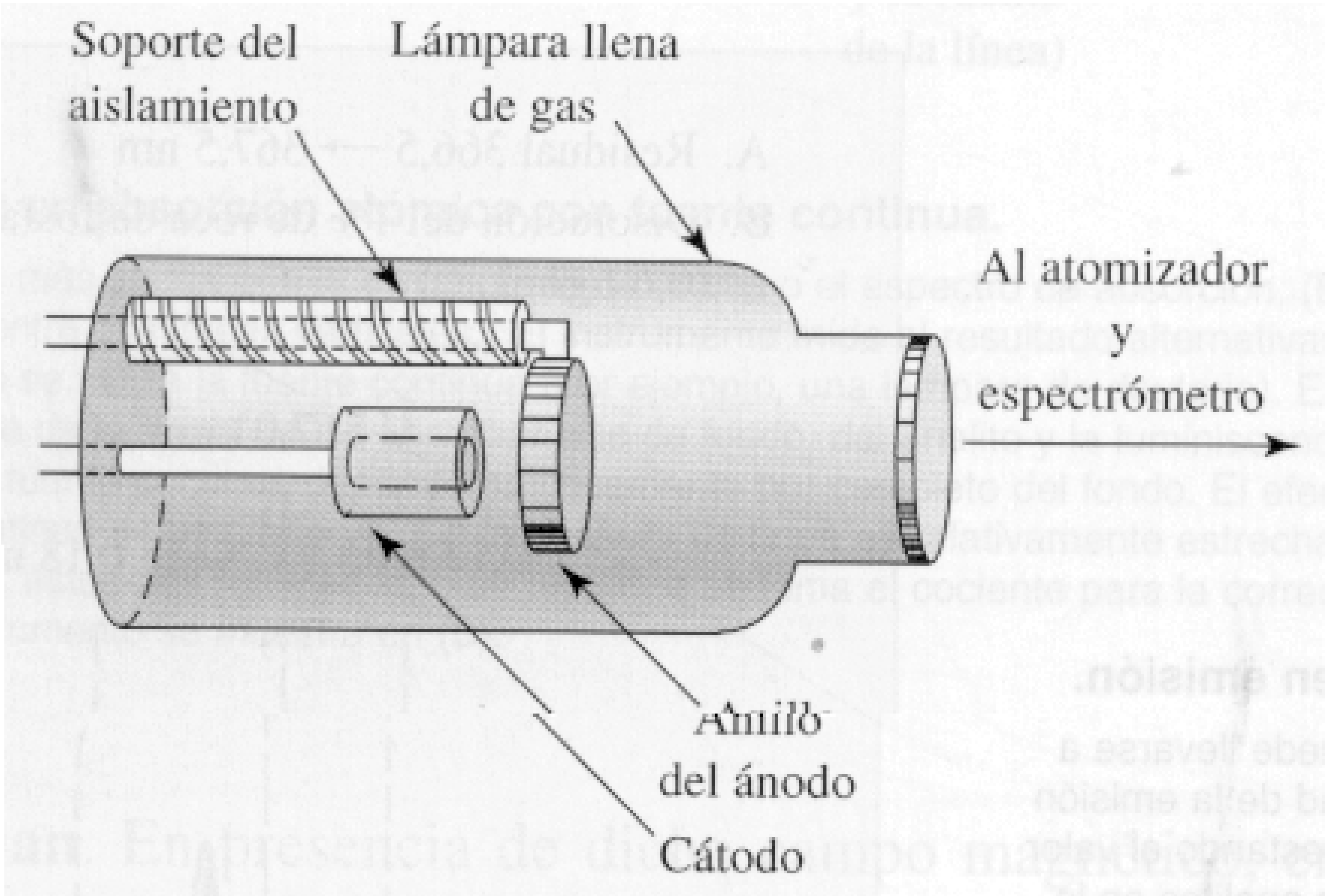


Fig. 11-12. Sección transversal esquemática de una lámpara de cátodo hueco.


Soporte del aislamiento
Lámpara llena de gas
Al atomizador y espectrómetro
Anillo del ánodo
Cátodo

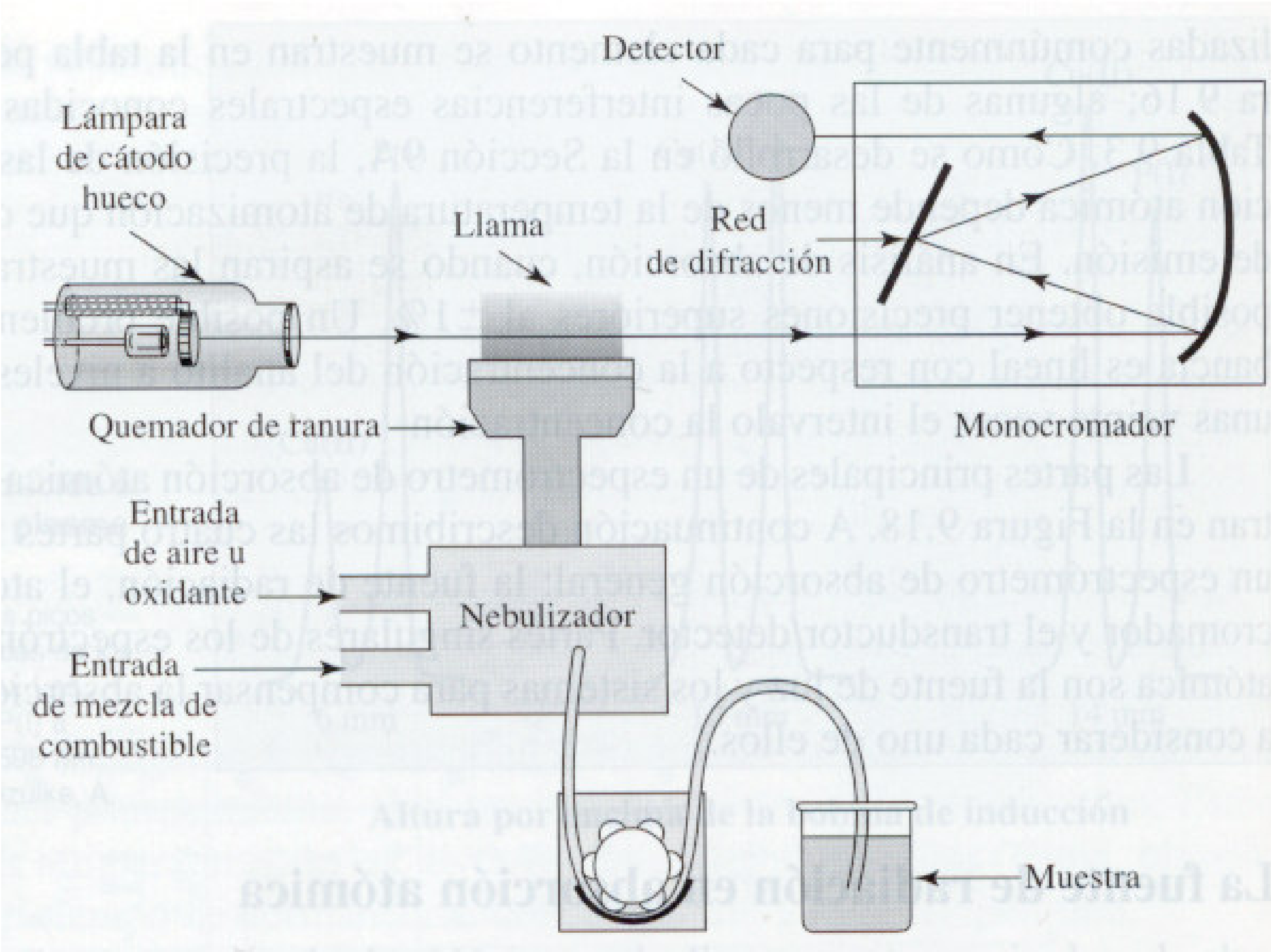

Detector
Lámpara
de cátodo
hueco
Llama
Red
de difracción
Quemador de ranura
Monocromador
Entrada
de aire u
oxidante
Nebulizador
Entrada
de mezcla de
combustible
Muestra

Tabla 11-3. Límites de detección para el análisis de algunos elementos por medio de la espectrometría de absorción atómica y de emisión en llama

Elemento	*Longitud de onda, nm*	*Límite de detección, µg/ml*		
		Absorción sin llama[a]	*Absorción en llama*[b]	*Emisión en llama*[b]
Aluminio	396.2	0.03		0.005 (N_2O)
	309.3		0.1 (N_2O)	
Calcio	422.7	0.0003	0.002 (aire)	0.005 (aire)
Cadmio	326.1	0.0001		2 (N_2O)
	228.8		0.005 (aire)	
Cromo	425.4	0.005		0.005 (N_2O)
	357.9		0.005 (aire)	
Hierro	372.0	0.003		0.05 (N_2O)
	248.3		0.005 (aire)	
Litio	670.8	0.005	0.005 (aire)	0.00003 (N_2O)
Magnesio	285.2	0.00006	0.00003 (aire)	0.005 (N_2O)
Potasio	766.5	0.0009	0.005 (aire)	0.0005 (aire)
Sodio	589.0	0.0001	0.002 (aire)	0.0005 (aire)

[a] Datos tomados de J.W. Robinson y P.J. Slevin, *American Laboratory*, 4 (8), 14 (1972). Con autorización de International Scientific Communications, Inc., Fairfield, CT © 1972; las longitudes de onda no se indican. Copyright 1972 de International Scientific Communications, Inc.

[b] Tomado de los datos reunidos por E.E. Pickett y S.R. Koirtyohann, *Anal. Chem.*, 41 (14), 28A (1969) y reproducidos con autorización de los autores. Copyright de American Chemical Society. Datos para una llama de acetileno con el oxidante indicado entre paréntesis.


217
SICA
ALCANCE DE TODOS
FISICA
DEL PLASMA
V. Milántiev
S. Temkó
EDITORIAL MIR MOSCU

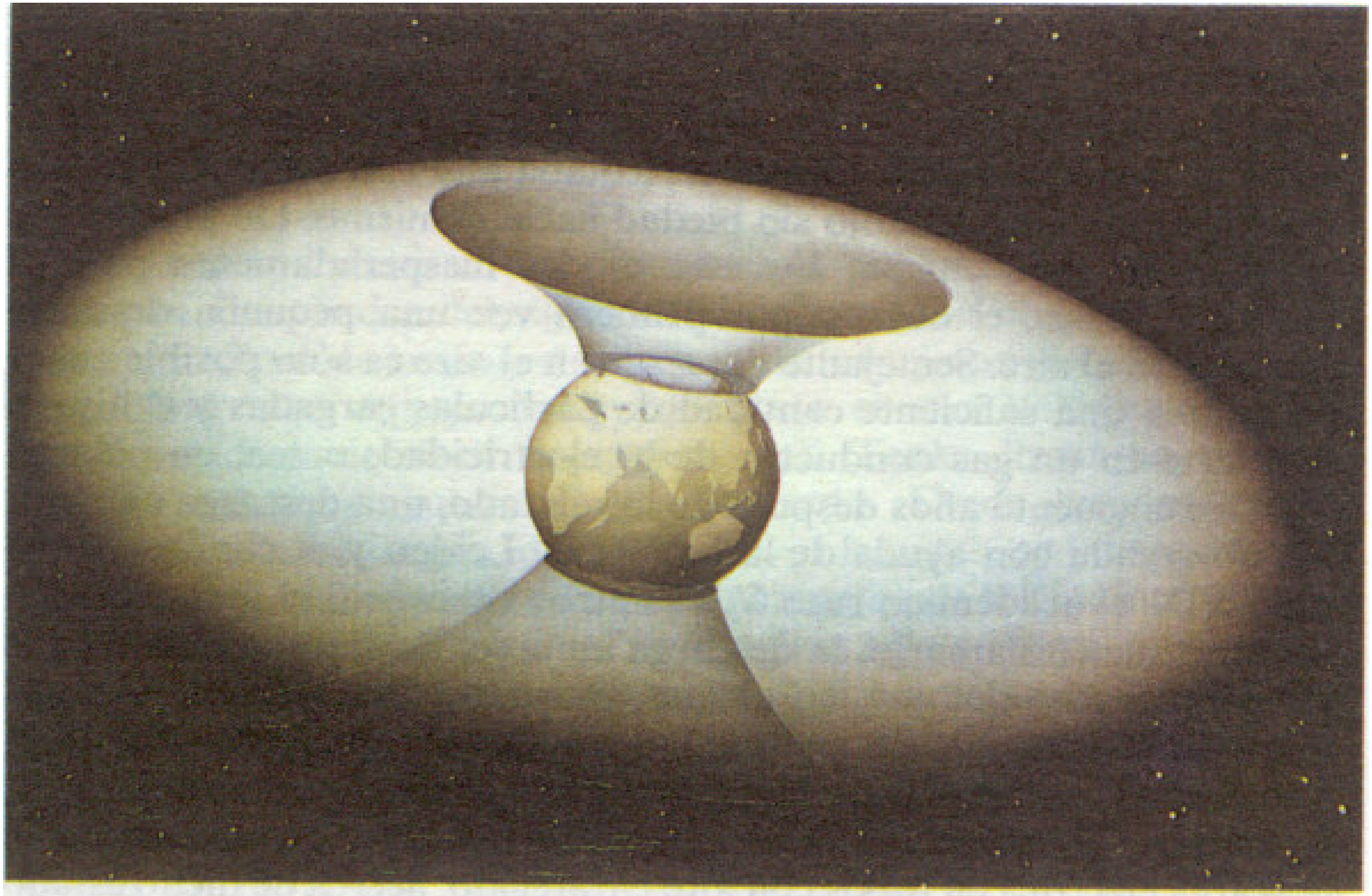


FIG. 1. *Cinturón de radiación de la Tierra.*

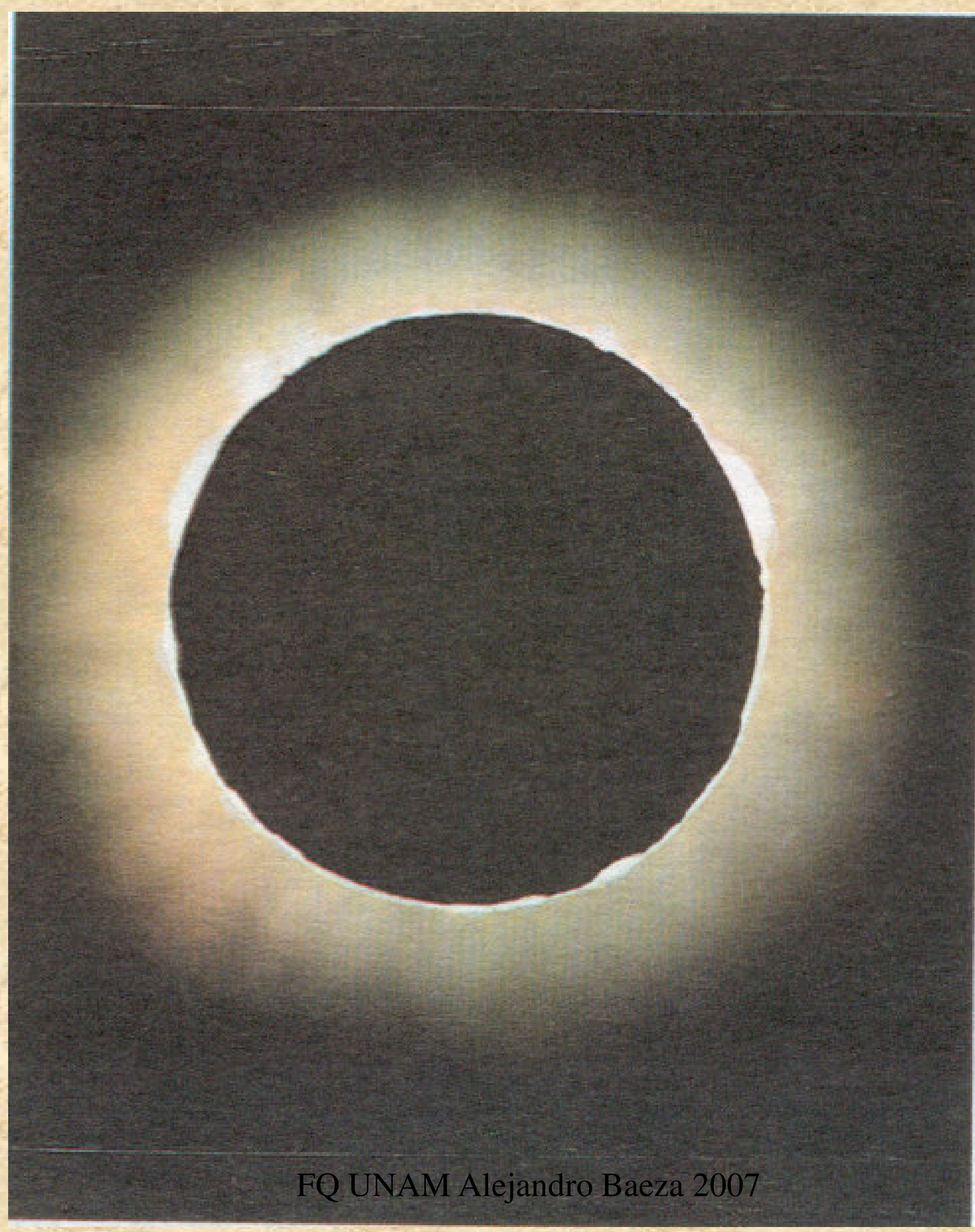


FIG. 2. *Aurora polar.*

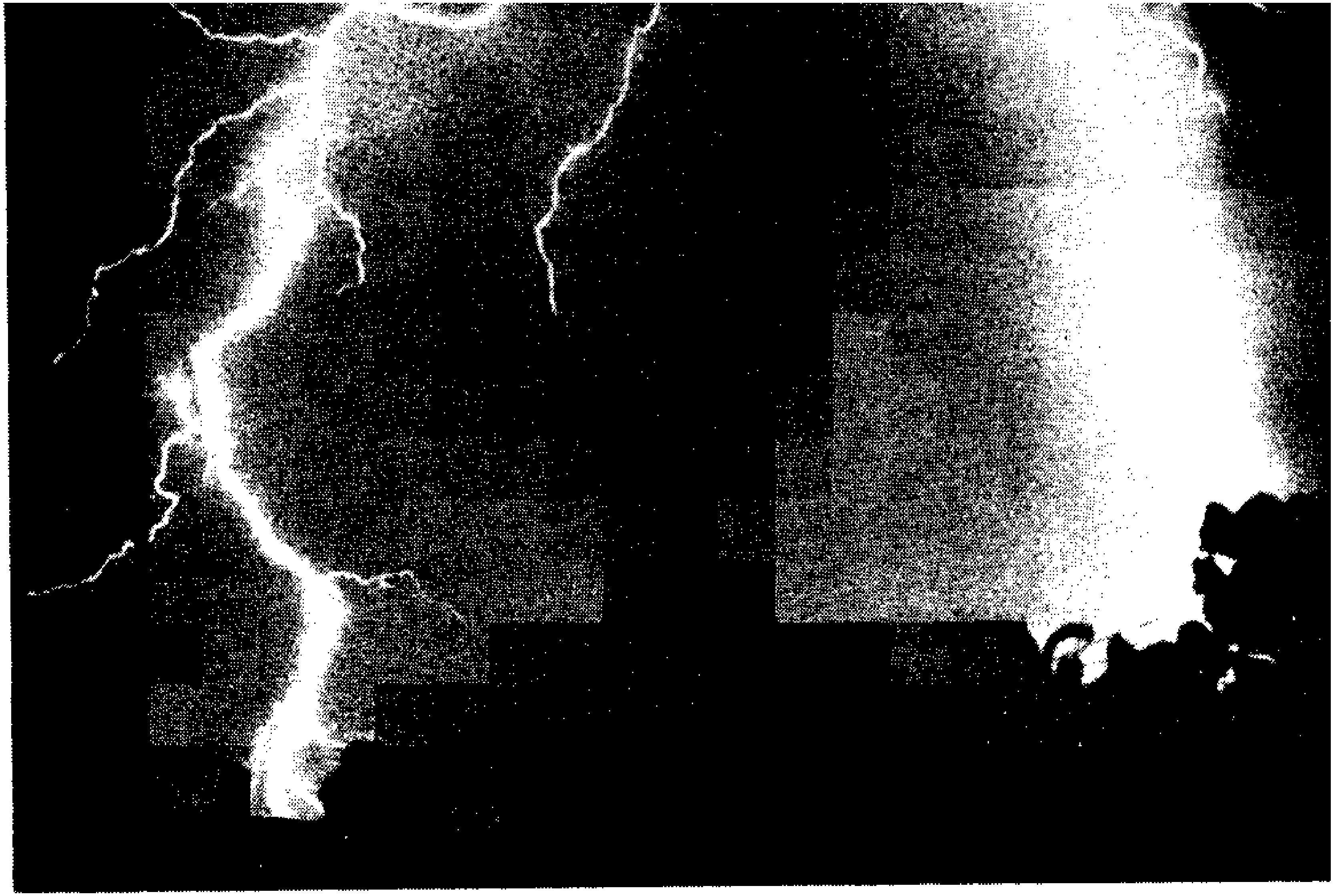


FIG. 7. *Relámpago.*

FIG. 3. *Huella luminosa de un rayo en bola.*

FIG. 4. *Flujo de plasma frío que sale de la tobera de un plasmatrón.*

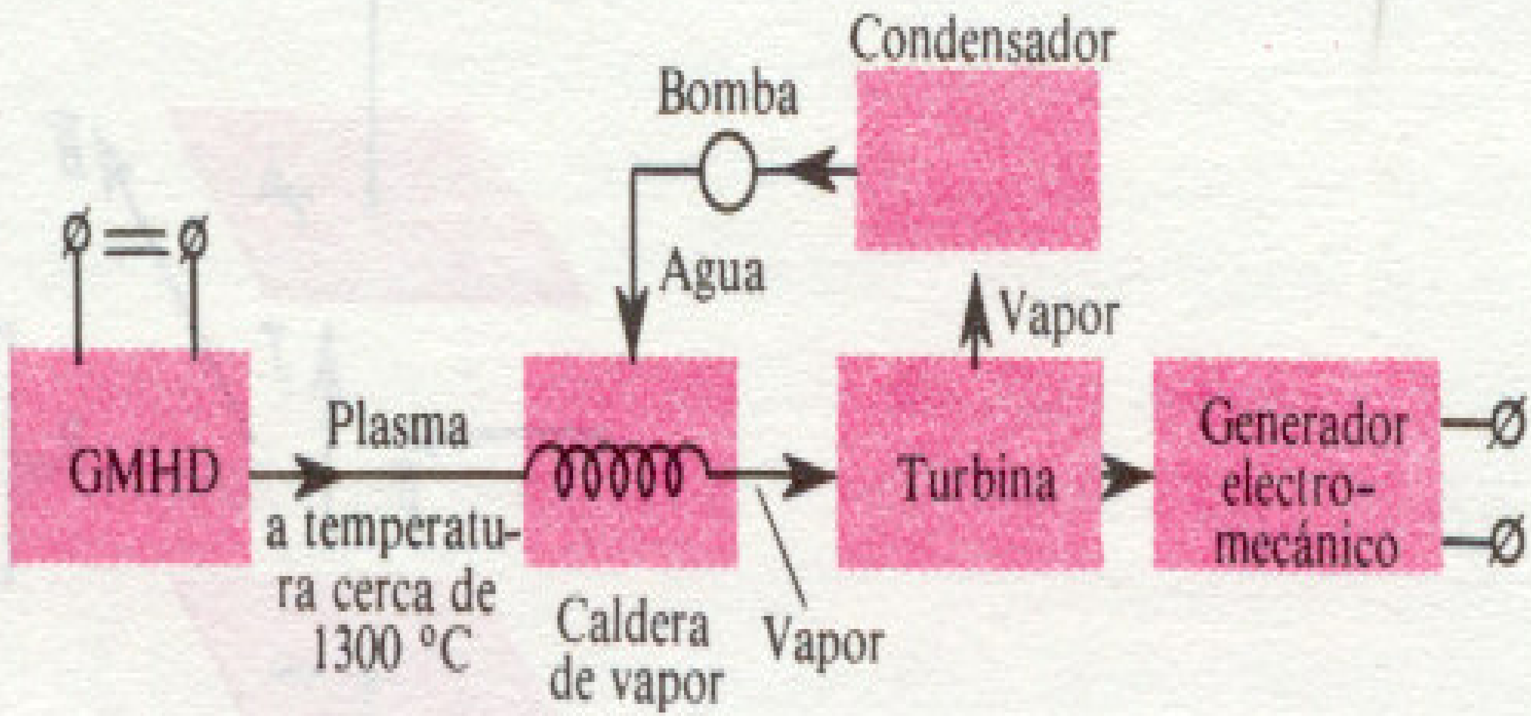


FIG. 74. *Esquema del funcionamiento conjunto de dos generadores: uno magnetohidrodinámico y el otro electromecánico en una central termoeléctrica.*

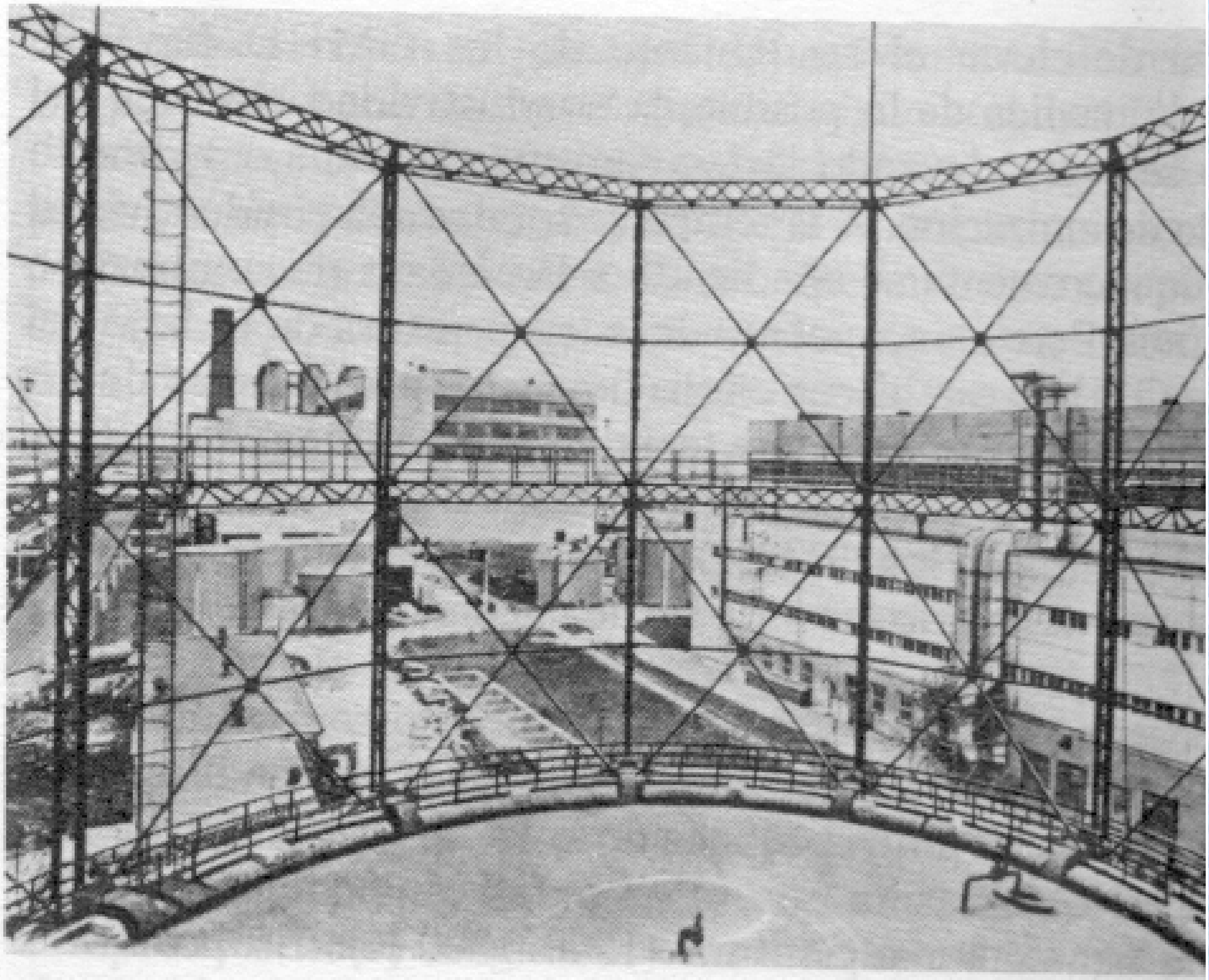


FIG. 75. *La primera central eléctrica MHD en el mundo, construida en la Unión Soviética (vista general).*

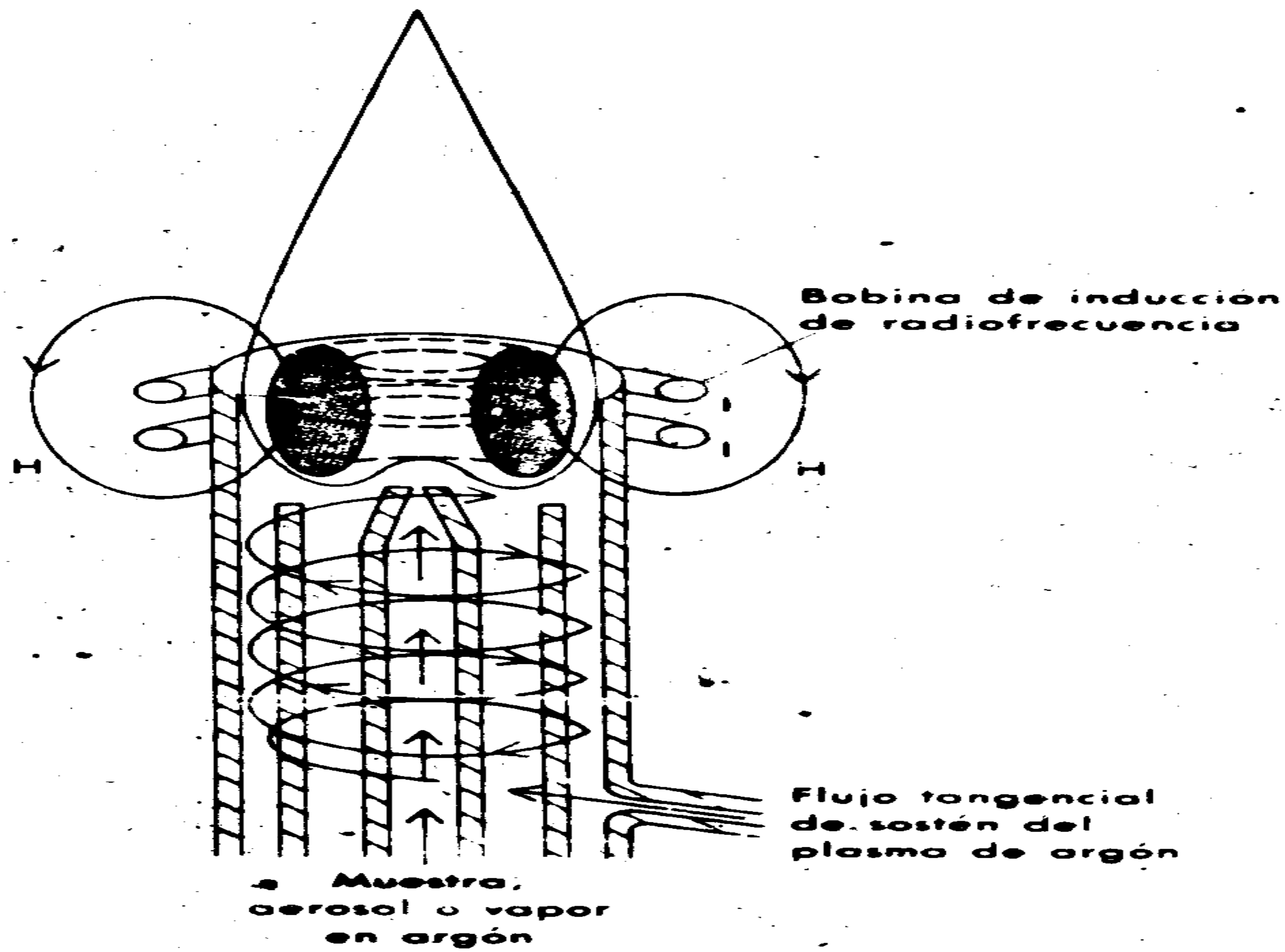
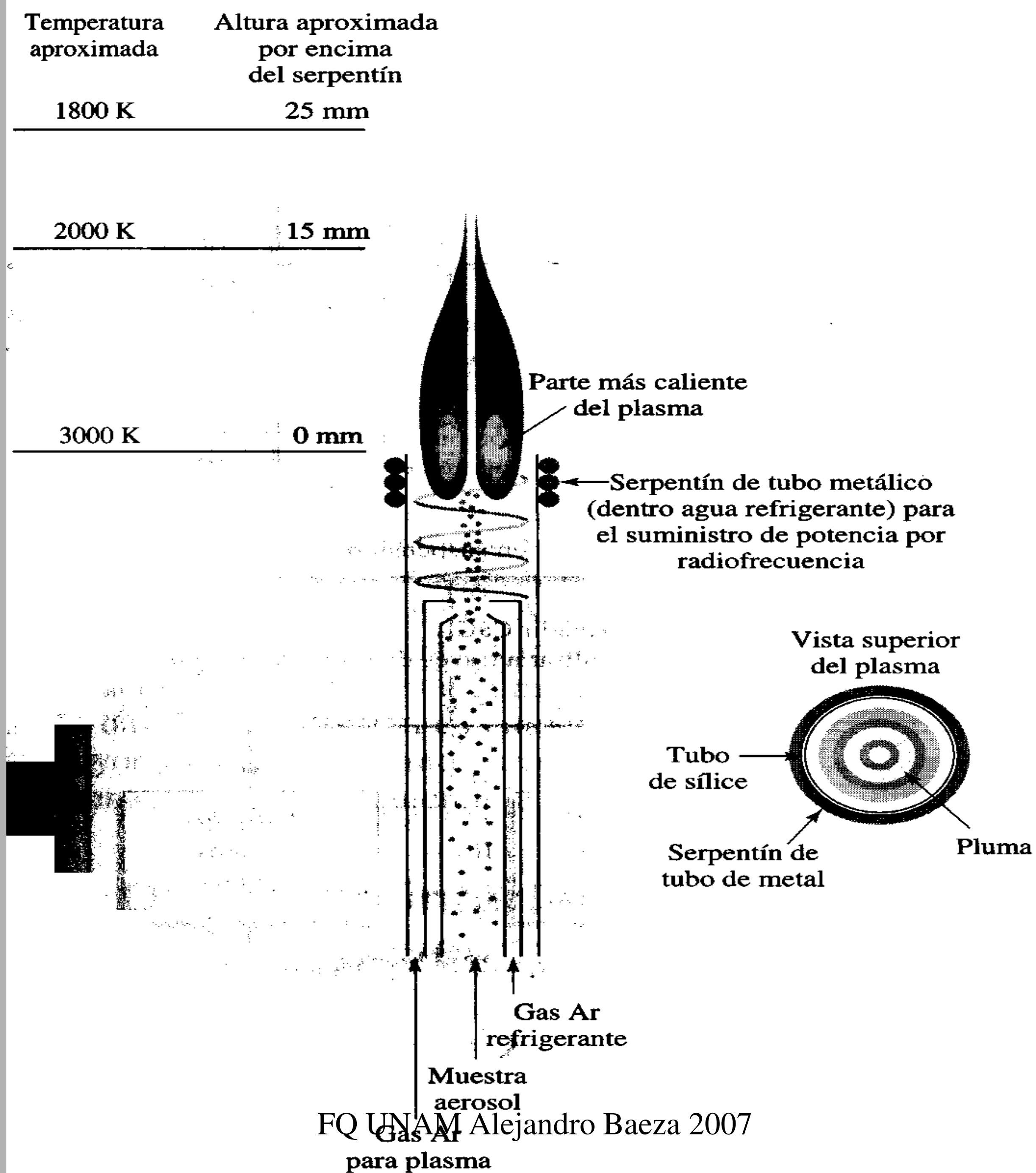


Fig. 12-2. Una fuente típica de plasma acoplado por inducción. (Tomado de V. A. Fassel, *Science*, 202, 185 (1978). Copyright 1978 de American Association for the Advancement of Science.)


Temperatura aproximada
Altura aproximada por encima del serpentín
1800 K
25 mm
2000 K
15 mm
3000 K
0 mm
Parte más caliente del plasma
Serpentín de tubo metálico (dentro agua refrigerante) para el suministro de potencia por radiofrecuencia
Vista superior del plasma
Tubo de sílice
Serpentín de tubo de metal
Pluma
Gas Ar refrigerante
Muestra aerosol
Gas Ar para plasma

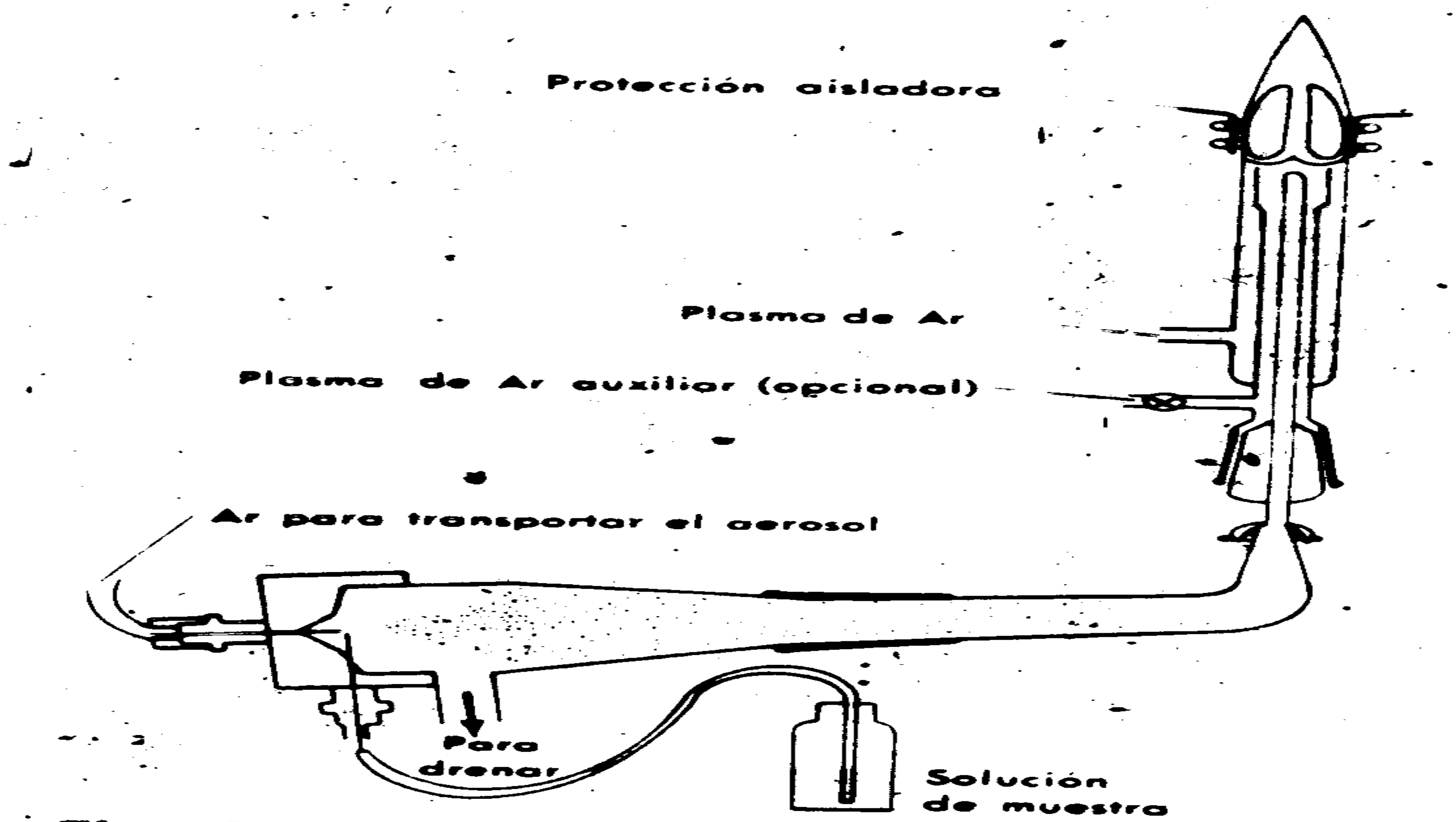
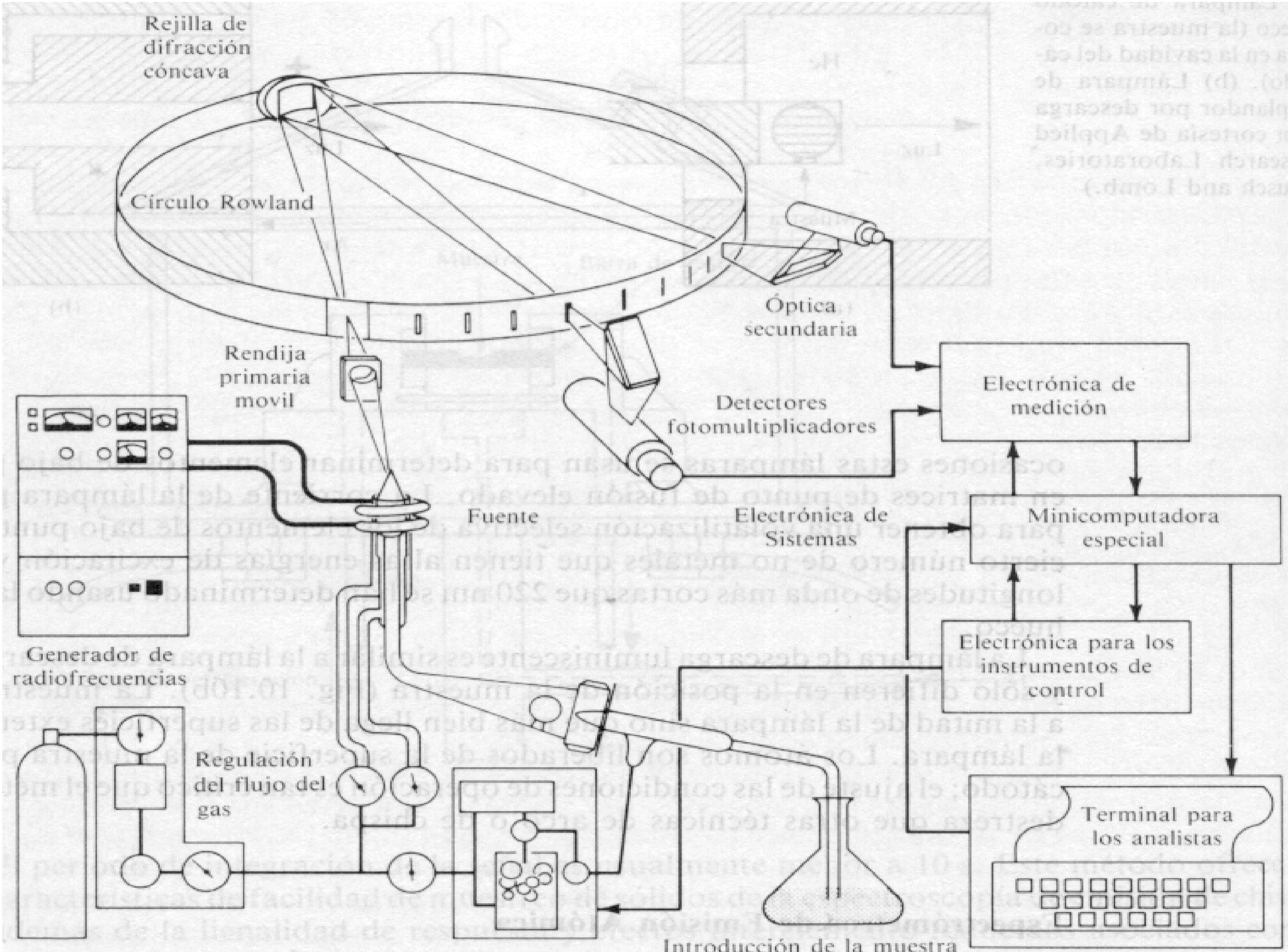


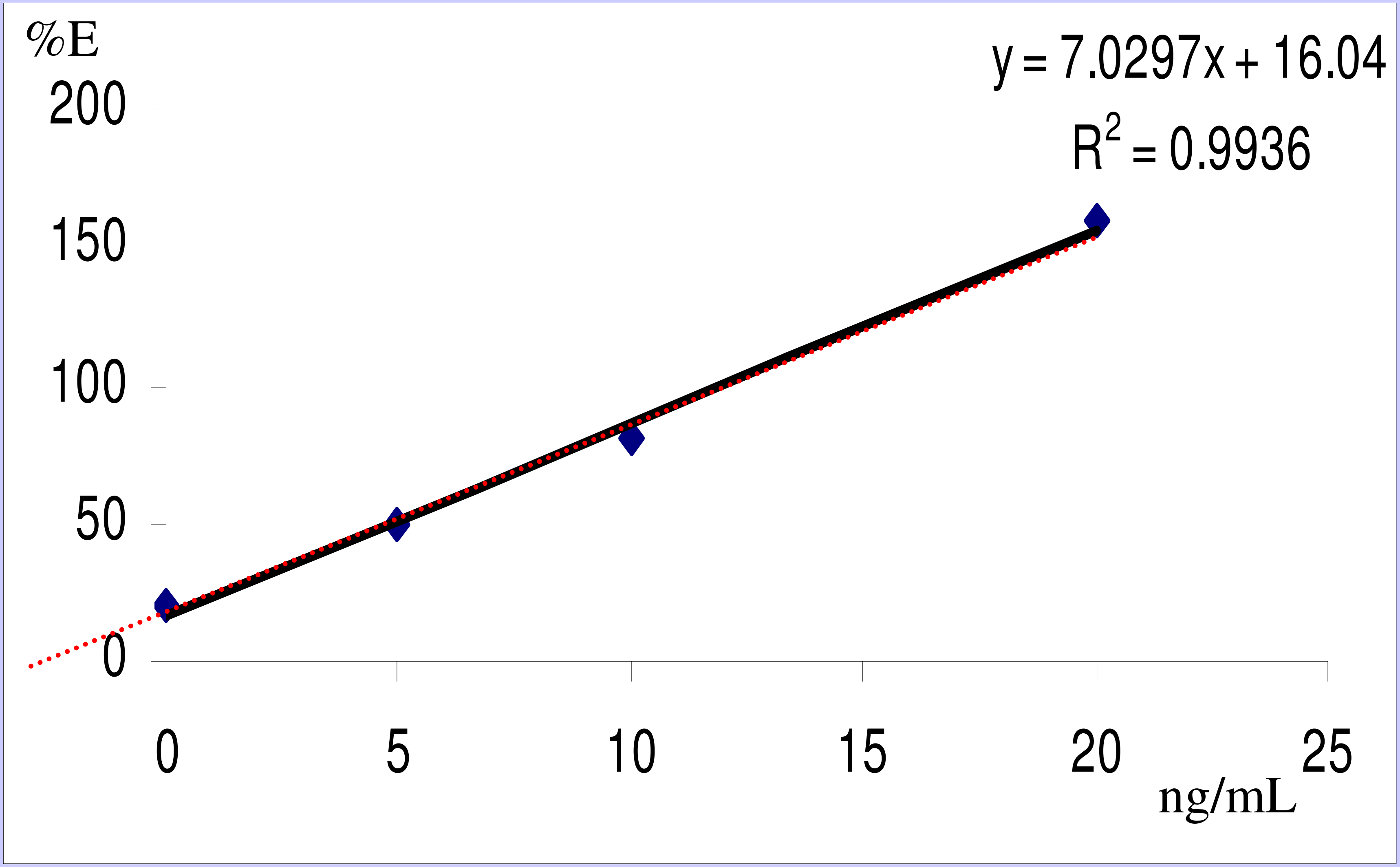
Fig. 12-3. Un nebulizador típico para inyección de muestra en una fuente de plasma. (Tomado de V.A. Fassel, *Science*, 202, 186 (1978). Con autorización. Copyright 1978 de American Asociation for the Advancement of Science.)


Rejilla de difracción cóncava
Círculo Rowland
Rendija primaria movil
Óptica secundaria
Detectores fotomultiplicadores
Electrónica de medición
Generador de radiofrecuencias
Fuente
Electrónica de Sistemas
Minicomputadora especial
Electrónica para los instrumentos de control
Regulación del flujo del gas
Terminal para los analistas
Espectrómetro de Emisión Atómica
Introducción de la muestra

3. Las siguientes señales de emisión se obtuvieron de un análisis con ICP de alícuotas de 25 μL de sangre completa a la que se agregó solución estándar de Mn. Las muestras de sangre se diluyeron primero 10 veces con HCl 0.1 *M*. Usando el método de adiciones estándar, calcule la concentración (μg/mL) de Mn en la muestra de sangre.

Solución	**Lectura de intensidad**
Muestra	25.3
Blanco	5.2
Muestra + 0.005 μg/mL Mn	55.2
Muestra + 0.010 μg/mL Mn	85.4
Muestra + 0.020 μg/mL Mn	165.3

Determinación de Mn en sangre por ICP



Cx= 0.44 ng/mL

"El que se va se lleva su memoria,
Su modo de ser río, de ser aire,
de ser adiós y nunca.

Hasta que un día otro lo para, lo detiene
y lo reduce a voz, a piel, a superficie
ofrecida, entregada, mientras dentro de sí
la oculta soledad aguarda y tiembla"

RCQ