

In [20]:

```
from skimage.io import imread, imshow, imsave
import numpy as np
from scipy.fftpack import fftshift, fft2
from scipy.signal import convolve2d
from skimage import img_as_float, img_as_ubyte
```

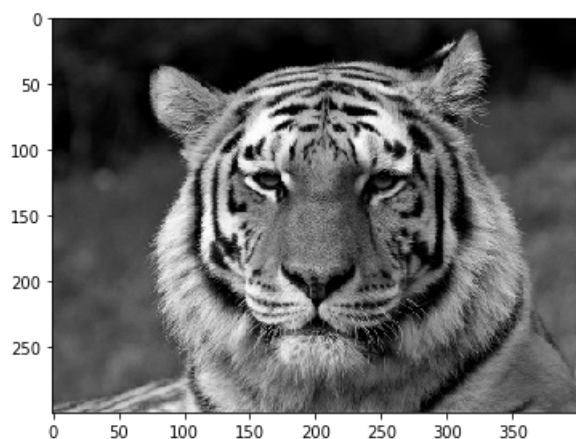
## 1 Для экспериментов будем использовать черно-белую картинку амурского тигра

In [3]:

```
img_tiger = imread('images/tiger-gray-small.png')
imshow(img_tiger)
```

Out[3]:

<matplotlib.image.AxesImage at 0x7f81f0ab99b0>



Опишем функции для получения гауссовского фильтра, свертки изображения, гауссовской пирамиды и прямого преобразования Фурье:

In [11]:

```
def gaussian(sigma, x, y):
    return np.exp(-(x ** 2 + y ** 2) / (2 * (sigma ** 2))) / (2 * np.pi * (sigma ** 2))
```

In [12]:

```
def get_gaussian(sigma):
    k = round(sigma * 3 * 2 + 1)

    kernel_list = []
    for y in range(k // 2, -k // 2, -1):
        for x in range(-k // 2 + 1, k // 2 + 1):
            kernel_list.append(gaussian(sigma, x, y))

    kernel = np.array(kernel_list).reshape((k, k))
    kernel /= np.sum(kernel)

    return kernel
```

In [13]:

```
def make_covolution(img, kernel):
    new_img = convolve2d(img, kernel, 'same', 'symm')
    new_img = np.clip(new_img, 0, 255).astype('uint8')

    return new_img
```

In [14]:

```
def get_gaussian_pyramid(img, sigma, n_layers):
    result_list = []
    result_list.append(img)
    for _ in range(n_layers):
        current_img = result_list[-1]
        kernel = get_gaussian(sigma)
        result = make_covolution(current_img, kernel)
        result_list.append(result)
    del result_list[0]

    return result_list
```

In [15]:

```
def get_fft(img):
    return np.log(1 + np.abs(fftshift(fft2(img))))
```

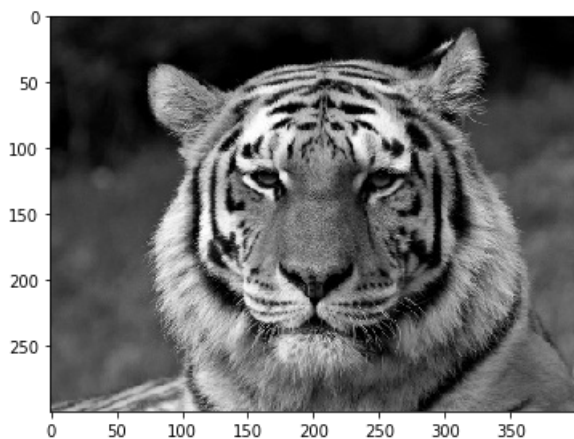
## 2 Получим частотное представление нашей картинки при помощи преобразования Фурье:

In [16]:

```
imshow(img_tiger)
```

Out[16]:

<matplotlib.image.AxesImage at 0x7f81eeca4160>



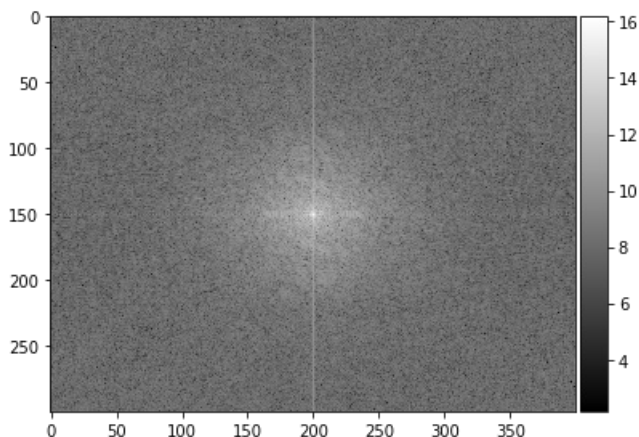
In [17]:

```
imshow(get_fft(img_tiger), cmap='gray')
```

/home/aldik/.local/lib/python3.6/site-packages/skimage/io/\_plugins/matplotlib\_plugin.py:150: UserWarning: Float image out of standard range; displaying image with stretched contrast.  
 lo, hi, cmap = \_get\_display\_range(image)

Out[17]:

<matplotlib.image.AxesImage at 0x7f81eec71e80>



Построим гаусовскую пирамиду для сигмы равной 1 и 5 слоев:

In [21]:

```
gaussian_pyramid_1 = get_gaussian_pyramid(img_tiger, 1, 5)
```

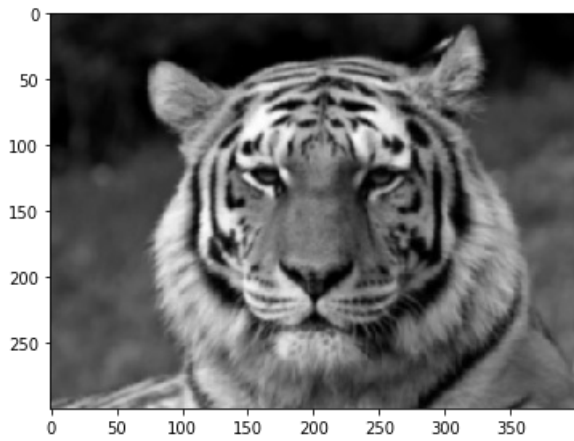
Посмотрим на результат:

In [22]:

```
imshow(gaussian_pyramid_1[0])
```

Out[22]:

<matplotlib.image.AxesImage at 0x7f81eeb272e8>



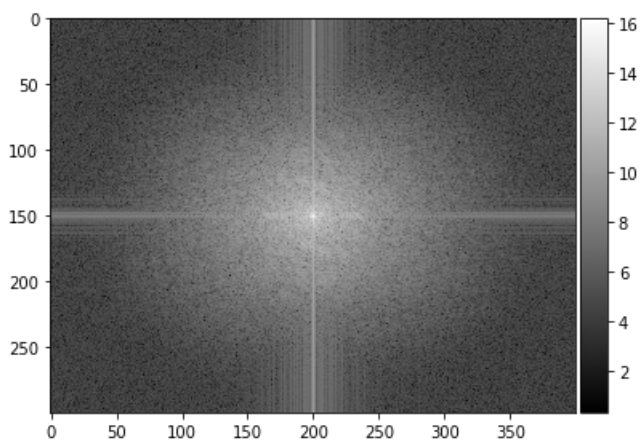
In [23]:

```
imshow(get_fft(gaussian_pyramid_1[0]), cmap='gray')
```

/home/aldik/.local/lib/python3.6/site-packages/skimage/io/\_plugins/matplotlib\_plugin.py:150: UserWarning: Float image out of standard range; displaying image with stretched contrast.  
 lo, hi, cmap = \_get\_display\_range(image)

Out[23]:

<matplotlib.image.AxesImage at 0x7f81eea7efd0>

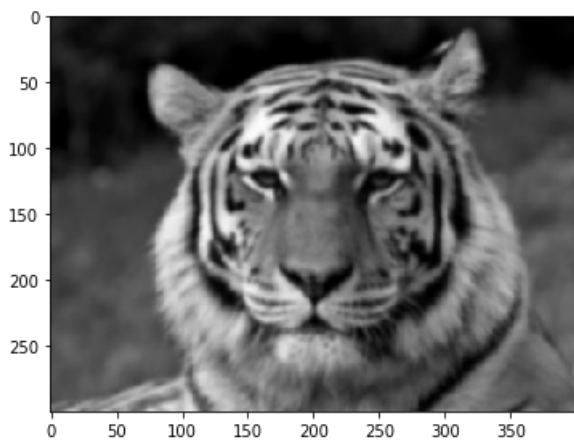


In [24]:

```
imshow(gaussian_pyramid_1[1])
```

Out[24]:

<matplotlib.image.AxesImage at 0x7f81eea2dac8>



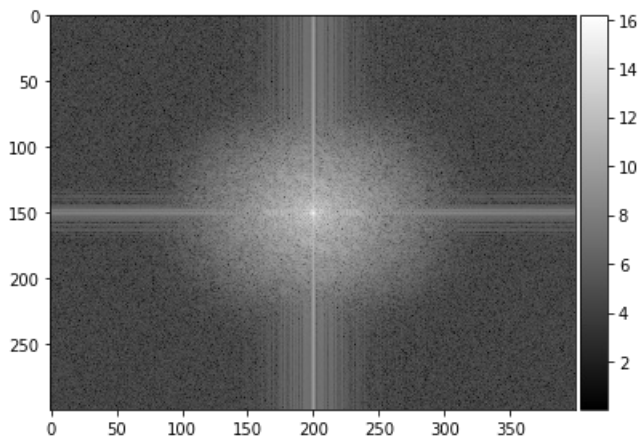
In [25]:

```
imshow(get_fft(gaussian_pyramid_1[1]), cmap='gray')
```

/home/aldik/.local/lib/python3.6/site-packages/skimage/io/\_plugins/matplotlib\_plugin.py:150: UserWarning: Float image out of standard range; displaying image with stretched contrast.  
 lo, hi, cmap = \_get\_display\_range(image)

Out[25]:

<matplotlib.image.AxesImage at 0x7f81ee9917f0>

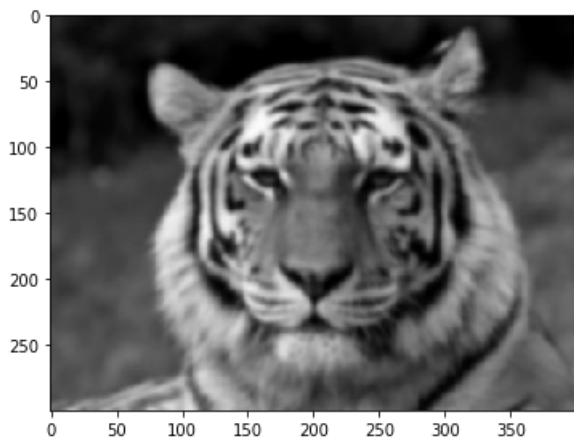


In [26]:

```
imshow(gaussian_pyramid_1[2])
```

Out[26]:

<matplotlib.image.AxesImage at 0x7f81ee8c82e8>



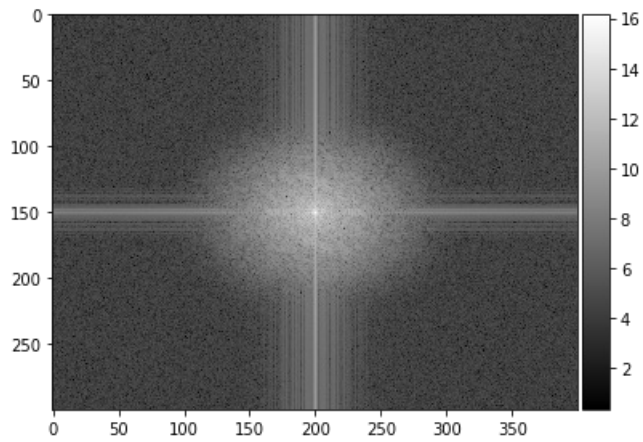
In [27]:

```
imshow(get_fft(gaussian_pyramid_1[2]), cmap='gray')
```

```
/home/aldik/.local/lib/python3.6/site-packages/skimage/io/_plugins/matplotlib_plugin.py:150: UserWarning: Float image out of standard range; displaying image with stretched contrast.  
    lo, hi, cmap = _get_display_range(image)
```

Out[27]:

<matplotlib.image.AxesImage at 0x7f81ee8a6fd0>

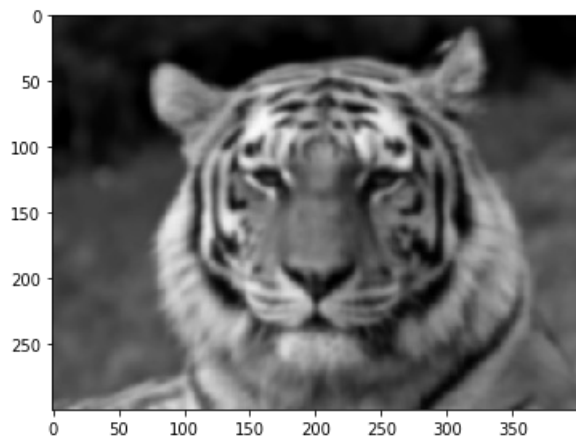


In [28]:

```
imshow(gaussian_pyramid_1[3])
```

Out[28]:

<matplotlib.image.AxesImage at 0x7f81ee7deac8>



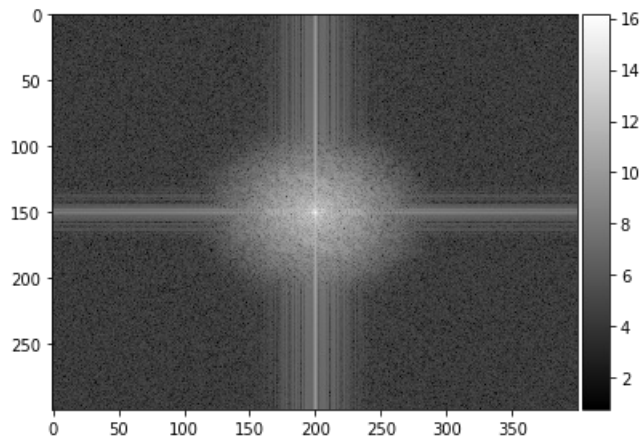
In [29]:

```
imshow(get_fft(gaussian_pyramid_1[3]), cmap='gray')
```

```
/home/aldik/.local/lib/python3.6/site-packages/skimage/io/_plugins/matplotlib_plugin.py:150: UserWarning: Float image out of standard range; displaying image with stretched contrast.  
    lo, hi, cmap = _get_display_range(image)
```

Out[29]:

<matplotlib.image.AxesImage at 0x7f81ee7457f0>

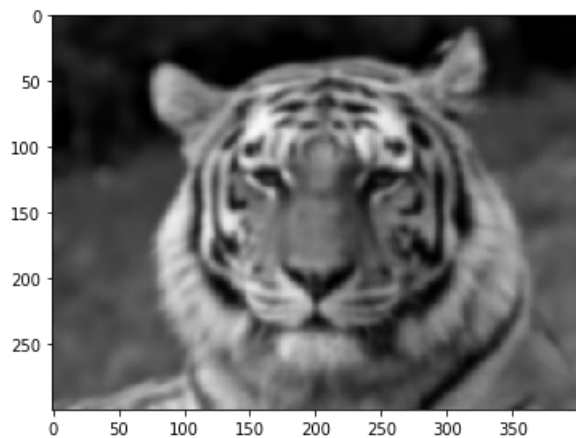


In [30]:

```
imshow(gaussian_pyramid_1[4])
```

Out[30]:

<matplotlib.image.AxesImage at 0x7f81ee67e2e8>



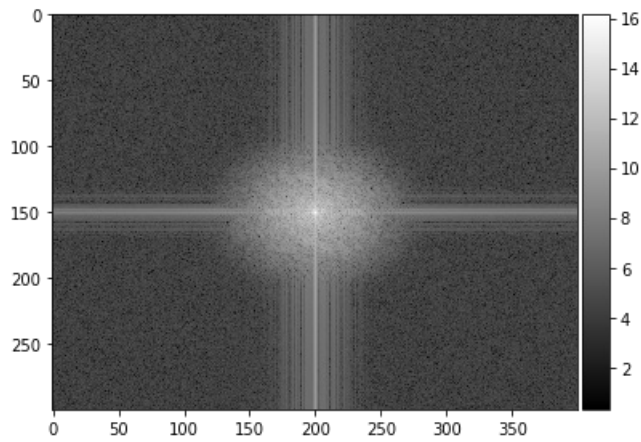
In [31]:

```
imshow(get_fft(gaussian_pyramid_1[4]), cmap='gray')
```

```
/home/aldik/.local/lib/python3.6/site-packages/skimage/io/_plugins/matplotlib_plugin.py:150: UserWarning: Float image out of standard range; displaying image with stretched contrast.  
    lo, hi, cmap = _get_display_range(image)
```

Out[31]:

<matplotlib.image.AxesImage at 0x7f81ee65afd0>



Посмотрим на пирамиду с сигма равной 5

In [32]:

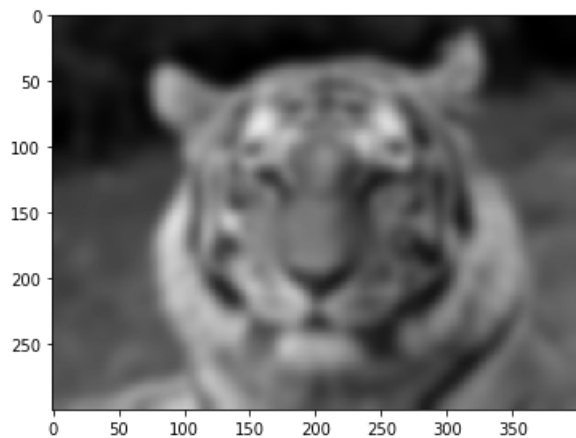
```
gaussian_pyramid_2 = get_gaussian_pyramid(img_tiger, 5, 5)
```

In [33]:

```
imshow(gaussian_pyramid_2[0])
```

Out[33]:

<matplotlib.image.AxesImage at 0x7f81ee583b00>





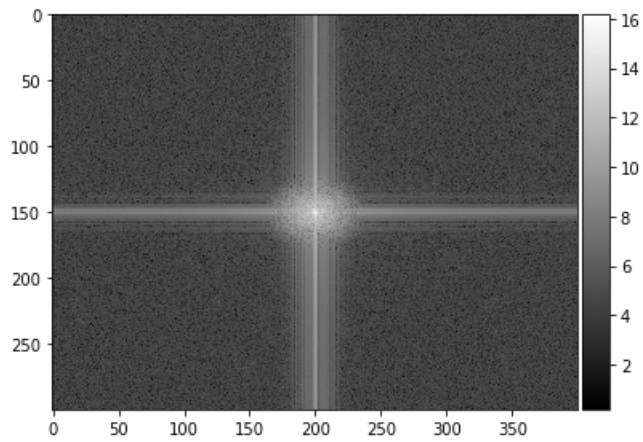
In [34]:

```
imshow(get_fft(gaussian_pyramid_2[0]), cmap='gray')
```

```
/home/aldik/.local/lib/python3.6/site-packages/skimage/io/_plugins/matplotlib_plugin.py:150: UserWarning: Float image out of standard range; displaying image with stretched contrast.  
  lo, hi, cmap = _get_display_range(image)
```

Out[34]:

<matplotlib.image.AxesImage at 0x7f81ee569828>

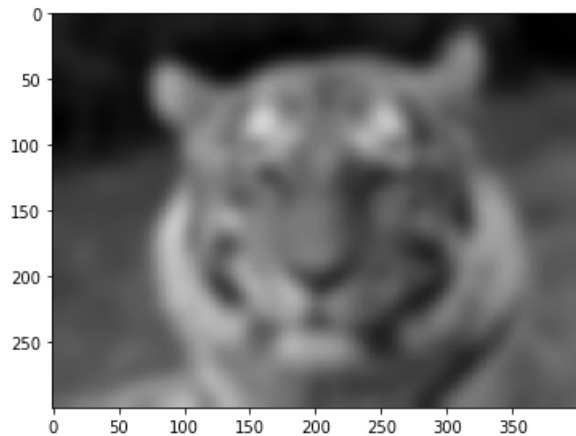


In [37]:

```
imshow(gaussian_pyramid_2[1])
```

Out[37]:

<matplotlib.image.AxesImage at 0x7f81ee3acb00>





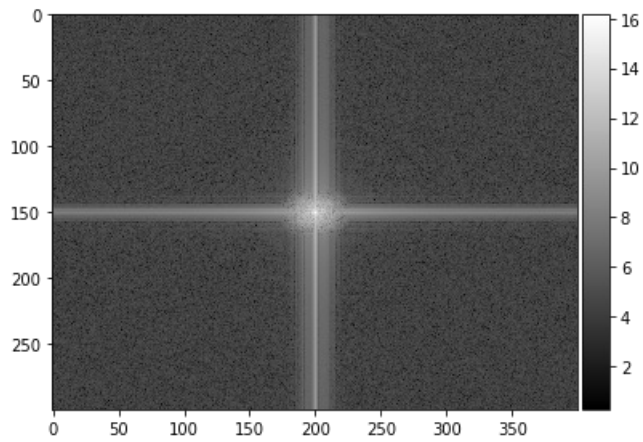
In [38]:

```
imshow(get_fft(gaussian_pyramid_2[1]), cmap='gray')
```

```
/home/aldik/.local/lib/python3.6/site-packages/skimage/io/_plugins/matplotlib_plugin.py:150: UserWarning: Float image out of standard range; displaying image with stretched contrast.  
  lo, hi, cmap = _get_display_range(image)
```

Out[38]:

<matplotlib.image.AxesImage at 0x7f81ee310828>

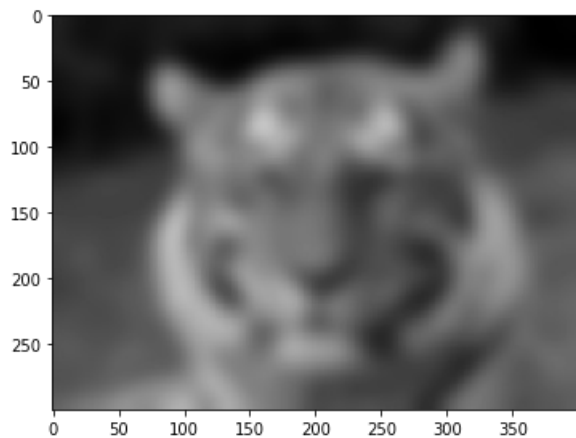


In [39]:

```
imshow(gaussian_pyramid_2[2])
```

Out[39]:

<matplotlib.image.AxesImage at 0x7f81ee244320>



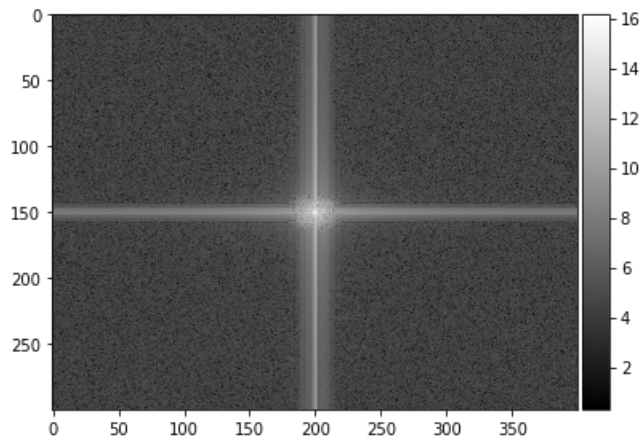
In [40]:

```
imshow(get_fft(gaussian_pyramid_2[2]), cmap='gray')
```

```
/home/aldik/.local/lib/python3.6/site-packages/skimage/io/_plugins/matplotlib_plugin.py:150: UserWarning: Float image out of standard range; displaying image with stretched contrast.  
    lo, hi, cmap = _get_display_range(image)
```

Out[40]:

<matplotlib.image.AxesImage at 0x7f81ee220fd0>

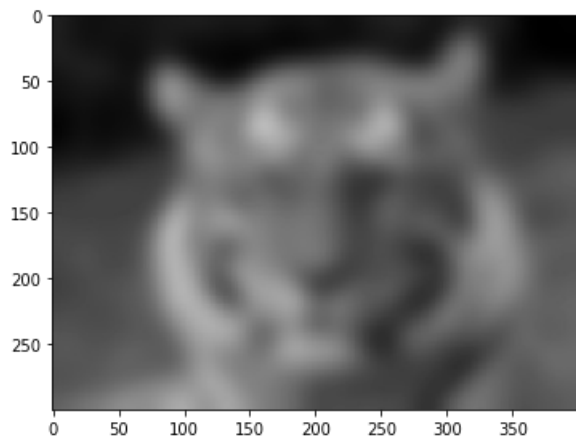


In [42]:

```
imshow(gaussian_pyramid_2[3])
```

Out[42]:

<matplotlib.image.AxesImage at 0x7f81ee0c1710>



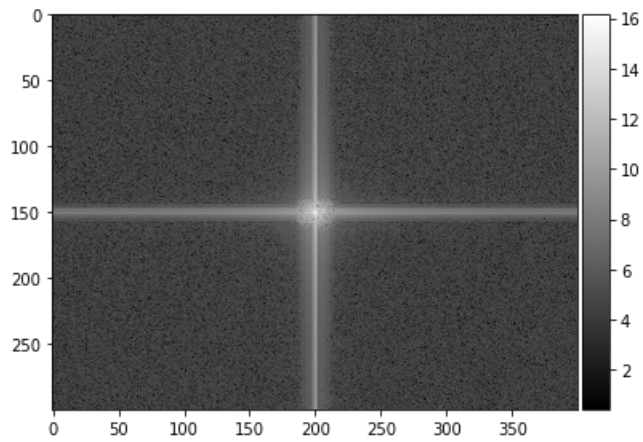
In [43]:

```
imshow(get_fft(gaussian_pyramid_2[3]), cmap='gray')
```

```
/home/aldik/.local/lib/python3.6/site-packages/skimage/io/_plugins/matplotlib_plugin.py:150: UserWarning: Float image out of standard range; displaying image with stretched contrast.  
  lo, hi, cmap = _get_display_range(image)
```

Out[43]:

<matplotlib.image.AxesImage at 0x7f81ee0a6438>

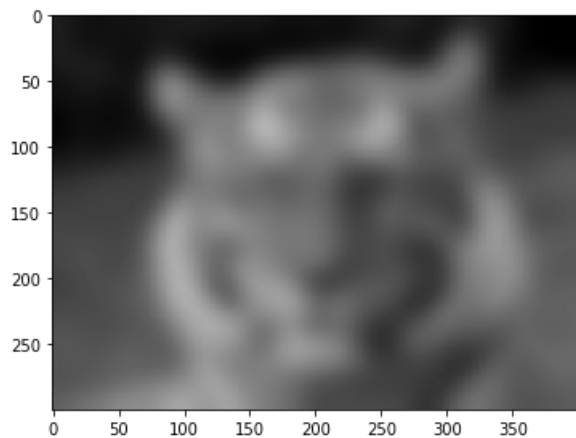


In [44]:

```
imshow(gaussian_pyramid_2[4])
```

Out[44]:

<matplotlib.image.AxesImage at 0x7f81edfd0ef0>



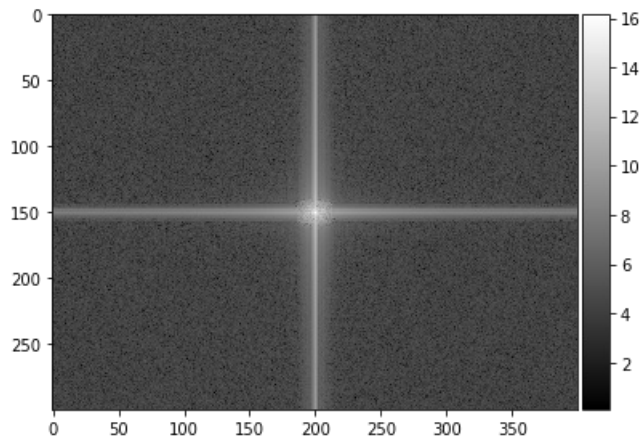
In [45]:

```
imshow(get_fft(gaussian_pyramid_2[4]), cmap='gray')
```

```
/home/aldik/.local/lib/python3.6/site-packages/skimage/io/_plugins/matplotlib_plugin.py:150: UserWarning: Float image out of standard range; displaying image with stretched contrast.  
  lo, hi, cmap = _get_display_range(image)
```

Out[45]:

<matplotlib.image.AxesImage at 0x7f81edfb3c18>



Сигма равна 11:

In [46]:

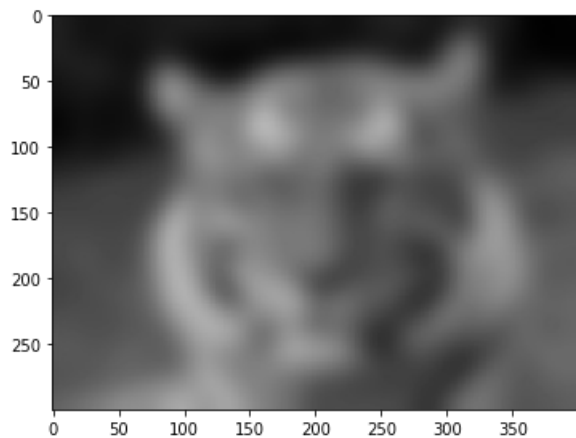
```
gaussian_pyramid_3 = get_gaussian_pyramid(img_tiger, 11, 5)
```

In [47]:

```
imshow(gaussian_pyramid_3[0])
```

Out[47]:

<matplotlib.image.AxesImage at 0x7f81edeea748>



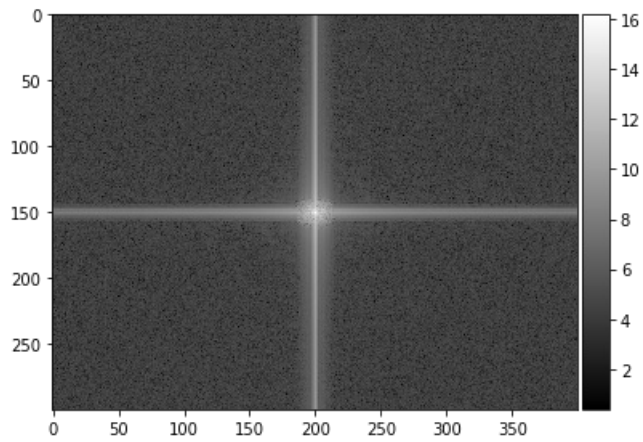
In [48]:

```
imshow(get_fft(gaussian_pyramid_3[0]), cmap='gray')
```

/home/aldik/.local/lib/python3.6/site-packages/skimage/io/\_plugins/matplotlib\_plugin.py:150: UserWarning: Float image out of standard range; displaying image with stretched contrast.  
 lo, hi, cmap = \_get\_display\_range(image)

Out[48]:

<matplotlib.image.AxesImage at 0x7f81ede4e470>

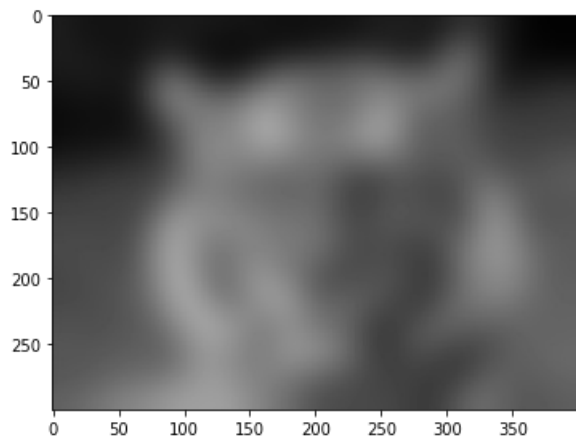


In [49]:

```
imshow(gaussian_pyramid_3[1])
```

Out[49]:

<matplotlib.image.AxesImage at 0x7f81eddfbf28>



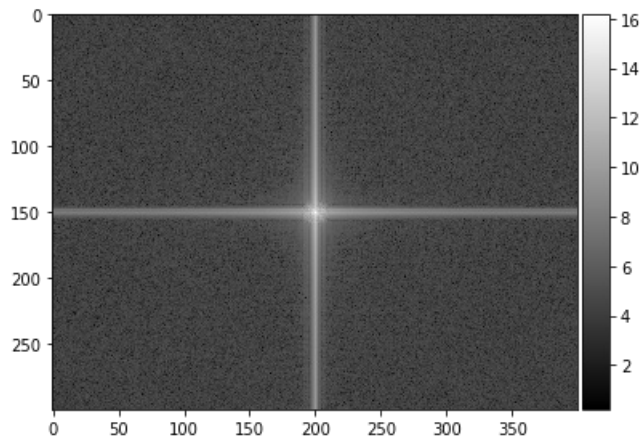
In [50]:

```
imshow(get_fft(gaussian_pyramid_3[1]), cmap='gray')
```

```
/home/aldik/.local/lib/python3.6/site-packages/skimage/io/_plugins/matplotlib_plugin.py:150: UserWarning: Float image out of standard range; displaying image with stretched contrast.  
    lo, hi, cmap = _get_display_range(image)
```

Out[50]:

<matplotlib.image.AxesImage at 0x7f81edd5cc50>

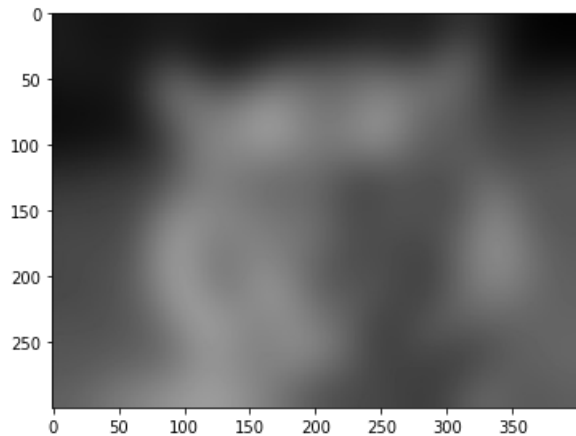


In [51]:

```
imshow(gaussian_pyramid_3[2])
```

Out[51]:

<matplotlib.image.AxesImage at 0x7f81edc90748>



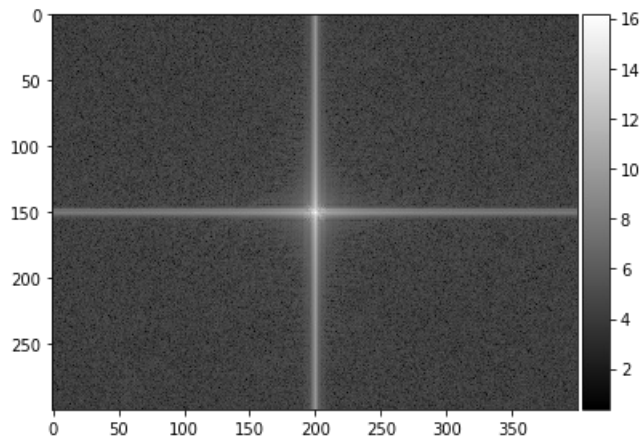
In [52]:

```
imshow(get_fft(gaussian_pyramid_3[2]), cmap='gray')
```

```
/home/aldik/.local/lib/python3.6/site-packages/skimage/io/_plugins/matplotlib_plugin.py:150: UserWarning: Float image out of standard range; displaying image with stretched contrast.  
  lo, hi, cmap = _get_display_range(image)
```

Out[52]:

<matplotlib.image.AxesImage at 0x7f81edc74470>

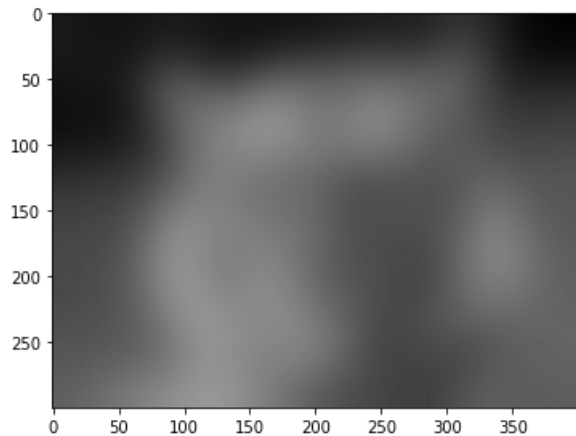


In [53]:

```
imshow(gaussian_pyramid_3[3])
```

Out[53]:

<matplotlib.image.AxesImage at 0x7f81edba2f28>





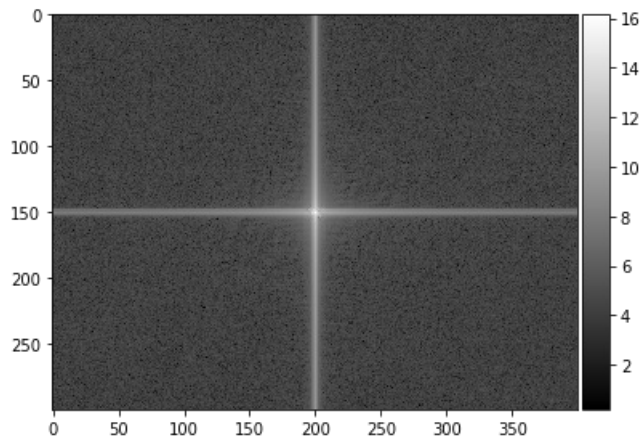
In [54]:

```
imshow(get_fft(gaussian_pyramid_3[3]), cmap='gray')
```

```
/home/aldik/.local/lib/python3.6/site-packages/skimage/io/_plugins/matplotlib_plugin.py:150: UserWarning: Float image out of standard range; displaying image with stretched contrast.  
    lo, hi, cmap = _get_display_range(image)
```

Out[54]:

<matplotlib.image.AxesImage at 0x7f81edb01c50>

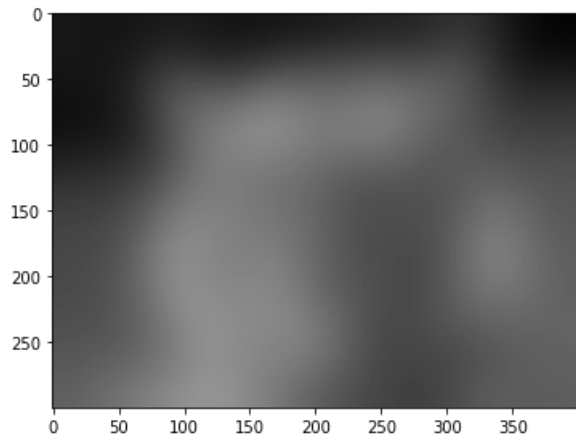


In [55]:

```
imshow(gaussian_pyramid_3[4])
```

Out[55]:

<matplotlib.image.AxesImage at 0x7f81edabb748>



In [56]:

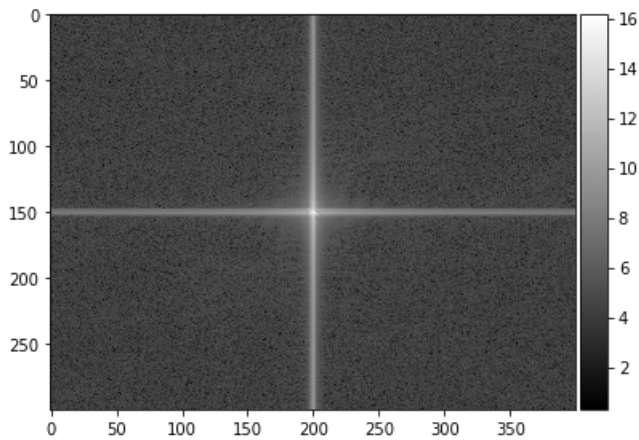
```
imshow(get_fft(gaussian_pyramid_3[4]), cmap='gray')
```

/home/aldik/.local/lib/python3.6/site-packages/skimage/io/\_plugins/matplotlib\_plugin.py:150: UserWarning: Float image out of standard range; displaying image with stretched contrast.

```
lo, hi, cmap = _get_display_range(image)
```

Out[56]:

<matplotlib.image.AxesImage at 0x7f81eda21470>



Видим сужение спектра частот с ростом количества слоев и увеличением сигмы гауссовского фильтра

### 3 построим лапласовскую пирамиду для нашего изображения:

Определим соответствующую функцию:

In [57]:

```
def get_laplassian_pyramid(img, sigma, n_layers):
    gaussian_pyramid = get_gaussian_pyramid(img, sigma, n_layers - 1)

    temp_list = []
    temp_list.append(img)
    temp_list += gaussian_pyramid

    laplassian_pyramid = []
    for i in range(n_layers - 1):
        laplassian = temp_list[i] - gaussian_pyramid[i]
        laplassian_pyramid.append(laplassian)

    laplassian_pyramid.append(gaussian_pyramid[-1])

    return laplassian_pyramid
```

In [58]:

```
laplassian_pyramid = get_laplassian_pyramid(img_tiger, 1, 5)
```

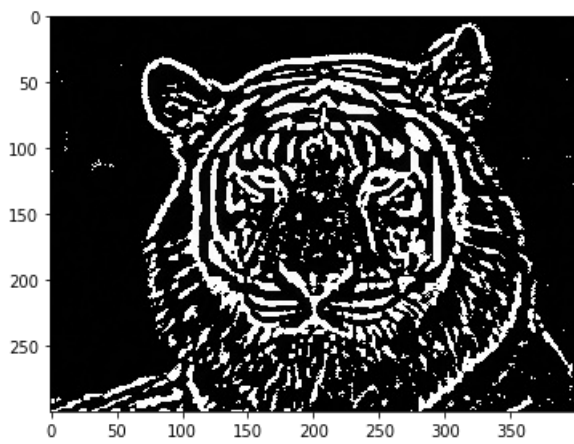
Посмотрим выборочно на некоторые изображения:

In [63]:

```
imshow(laplassian_pyramid[3])
```

Out[63]:

<matplotlib.image.AxesImage at 0x7f81ed7a66a0>



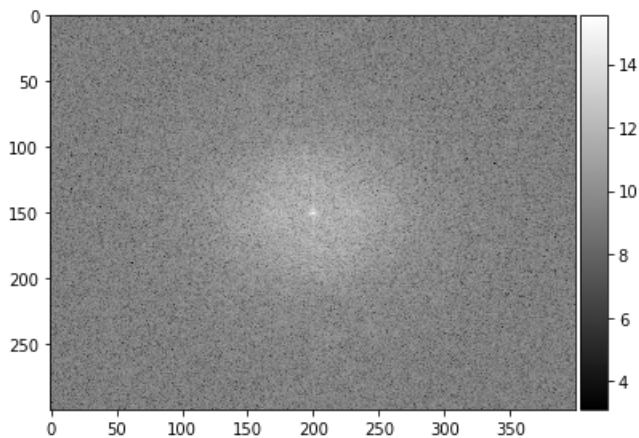
In [64]:

```
imshow(get_fft(laplassian_pyramid[3]), cmap='gray')
```

/home/aldik/.local/lib/python3.6/site-packages/skimage/io/\_plugins/matplotlib\_plugin.py:150: UserWarning: Float image out of standard range; displaying image with stretched contrast.  
 lo, hi, cmap = \_get\_display\_range(image)

Out[64]:

<matplotlib.image.AxesImage at 0x7f81ed70c3c8>



In [65]:

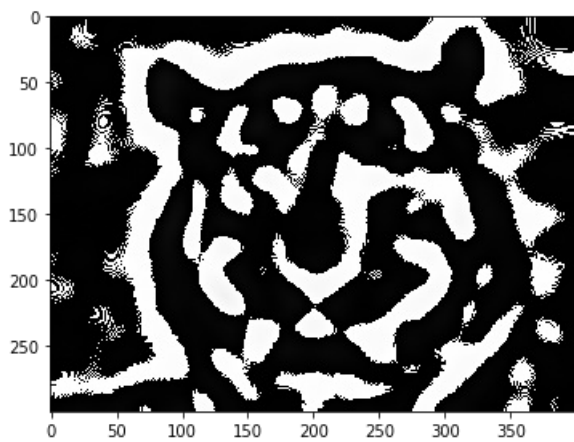
```
laplassian_pyramid_2 = get_laplassian_pyramid(img_tiger, 5, 5)
```

In [66]:

```
imshow(laplassian_pyramid_2[3])
```

Out[66]:

<matplotlib.image.AxesImage at 0x7f81ed6b7470>



In [67]:

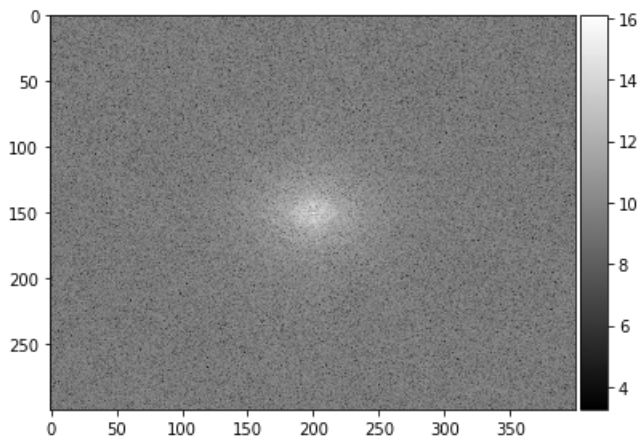
```
imshow(get_fft(laplassian_pyramid_2[]), cmap='gray')
```

/home/aldik/.local/lib/python3.6/site-packages/skimage/io/\_plugins/matplotlib\_plugin.py:150: UserWarning: Float image out of standard range; displaying image with stretched contrast.

lo, hi, cmap = \_get\_display\_range(image)

Out[67]:

<matplotlib.image.AxesImage at 0x7f81ed61d198>



In [68]:

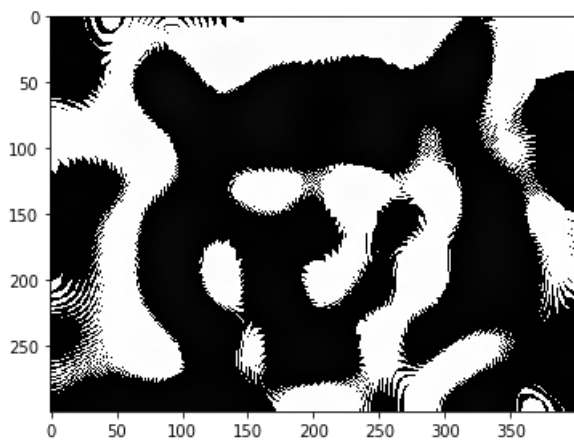
```
laplassian_pyramid_3 = get_laplassian_pyramid(img_tiger, 11, 5)
```

In [69]:

```
imshow(laplassian_pyramid_3[3])
```

Out[69]:

<matplotlib.image.AxesImage at 0x7f81ed547780>



Восстановим наше изображение из лапласовской пирамиды:

In [70]:

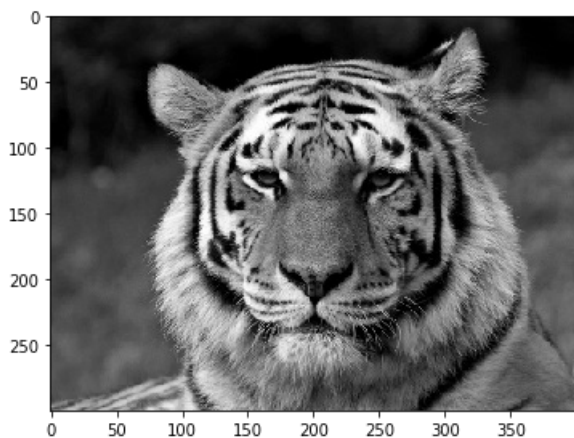
```
img_from_laplasians = laplassian_pyramid_3[0] + laplassian_pyramid_3[1] + laplassian_pyramid_3[2] + laplassian_pyramid_3[3] + laplassian_pyramid_3[4]
```

In [71]:

```
imshow(img_from_laplasians)
```

Out[71]:

<matplotlib.image.AxesImage at 0x7f81ed52d320>



## 4 Склеим 2 изображения

In [85]:

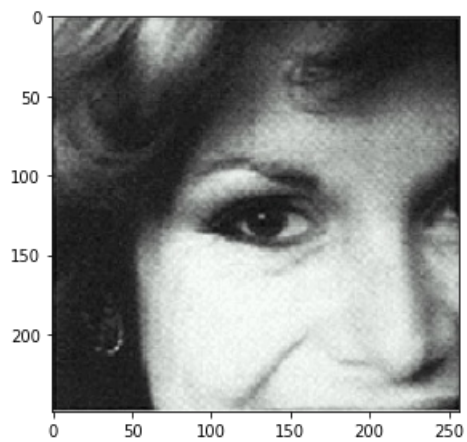
```
img_a = imread('images/a.png')  
img_b = imread('images/b.png')  
mask = imread('images/mask.png')
```

In [73]:

```
imshow(img_a)
```

Out[73]:

<matplotlib.image.AxesImage at 0x7f81ed487f98>

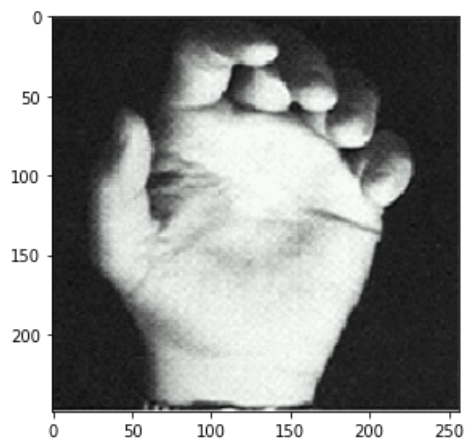


In [74]:

```
imshow(img_b)
```

Out[74]:

<matplotlib.image.AxesImage at 0x7f81ed462ba8>

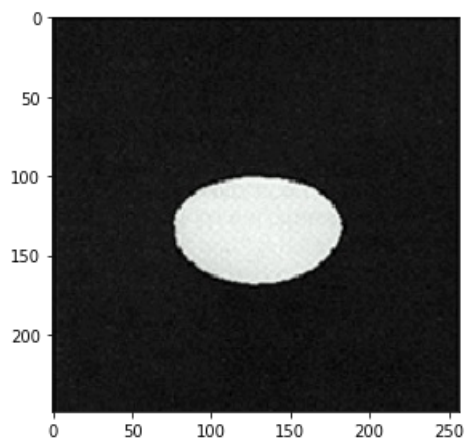


In [75]:

```
imshow(mask)
```

Out[75]:

<matplotlib.image.AxesImage at 0x7f81ed3c07b8>



Определим метод для получения значения яркости изображения:

In [76]:

```
def get_yuv(img):
    img_f = img_as_float(img)

    red = img_f[:, :, 0]
    green = img_f[:, :, 1]
    blue = img_f[:, :, 2]

    y = 0.2126 * red + 0.7152 * green + 0.0722 * blue
    u = -0.0999 * red - 0.336 * green + 0.4360 * blue
    v = 0.615 * red - 0.5586 * green - 0.0563 * blue

    return y, u, v
```

Бинаризуем маску:

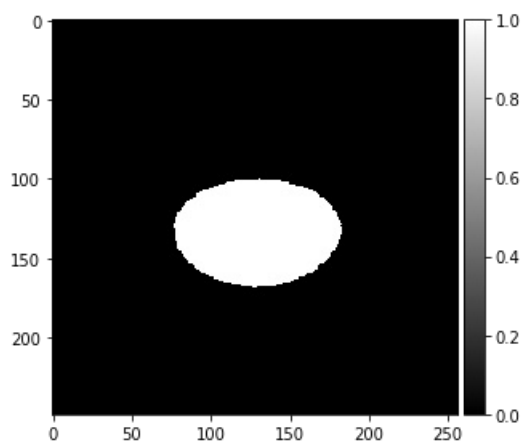
In [86]:

```
mask_y, mask_u, mask_v = get_yuv(mask)
mask = (mask_y > 0.5).astype('uint')
imshow(mask, cmap='gray')
```

```
/home/aldik/.local/lib/python3.6/site-packages/skimage/io/_plugins/matplotlib_plugin.py:150: UserWarning: Low image data range; displaying image with stretched contrast.
  lo, hi, cmap = _get_display_range(image)
```

Out[86]:

<matplotlib.image.AxesImage at 0x7f81ed2ec6a0>



Метод для получения склеинного изображения и лапласовской пирамиды:

In [87]:

```
def combine_images(img_a, img_b, mask, sigma, n_layers):

    a_y, a_u, a_v = get_yuv(img_a)
    b_y, b_u, b_v = get_yuv(img_b)

    img_a_y = img_as_ubyte(a_y)
    img_b_y = img_as_ubyte(b_y)

    laplassion_pyramid_a = get_laplassion_pyramid(img_a_y, sigma, n_layers)
    laplassion_pyramid_b = get_laplassion_pyramid(img_b_y, sigma, n_layers)
    gaussian_pyramid_mask = get_gaussian_pyramid(mask, sigma, n_layers)

    pyramid = []
    combine_images = np.zeros_like(img_a_y)
    for i in range(n_layers):
        result = laplassion_pyramid_a[i] * gaussian_pyramid_mask[i] + laplassion_pyramid_b[i] * (1 - gaussian_pyramid_mask[i])
        pyramid.append(result)
        combine_images += result

    return combine_images, pyramid
```

Склеим изображения:



In [88]:

```
img , pyramid = combine_images(img_a, img_b, mask, 1, 5)
```

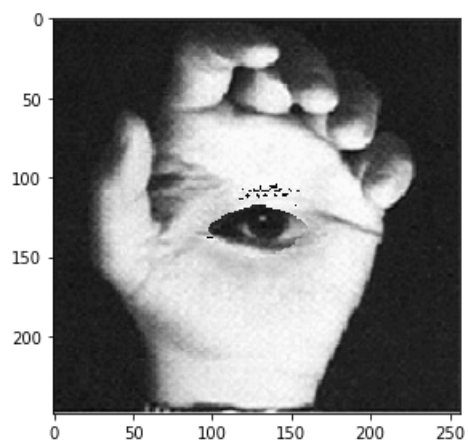
Посмотрим на результат:

In [89]:

```
imshow(img)
```

Out[89]:

```
<matplotlib.image.AxesImage at 0x7f81ed20c780>
```



In [ ]: